THE

JOURNAL OF GAS LIGHTING,

WATER SUPPLY, & SANITARY IMPROVEMENT.

[REGISTERED AS A NEWSPAPER.]

VOL. XXVIII. No. 687.] LONDON, JULY 11, 1876. [28TH YEAR.] Price 6d.

RAMSAY'S NEWCASTLE CANNEL COAL. Analysis—12,000 cubic feet of gas per ton of coal; 28-candle gas; coke 66·70 per cent.; volatile matters 33·30 per cent. Coke of good quality.

RAMSAY'S PATENT CONDENSED GARESFIELD COKE.

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RAMSAY'S FIRE-CLAY ARTICLES.

GAS-RETORTS, introduced 1838. FIRE-BRICK WORKS, established 1804. FIRE-CLAY SANITARY PIPES, CHIMNEY-TOPS, and all Goods made of Fire-Clay. The Fire-Clay is worked from Blaydon Main Colliery, is of excellent quality, and no expense spared in perfecting every article. The FIRE-BRICKS (marked "RAMSAY") are to be seen in all parts of the world, and the Works are the most extensive in the Kingdom.

Manufactories—Derwenthaugh, Swalwell, and Hebburn Quay, near Newcastle-on-Tyne.

Address G. H. RAMSAY, NEWCASTLE-ON-TYNE.

London, at the Lombard Exchange, 39, LOMBARD ST., E.C.

GENUINE TORBAY PAINT
AND
SPECIAL GASOMETER PAINT
(Mixed ready for use).

These Paints are now used in 100 Country Gas-Works, and by all (but one) of the London Gas Companies, on Gasholders, Scrubbers, Purifiers, &c. They will cover tar effectually. Also used by the Admiralty, War Office, Railway Companies, Founders, &c.

They prevent and arrest rust, and protect iron from the action of water, sulphurous and gaseous exhalations.

The covering powers are considerably greater than those of any other Paint.—*See "Engineer," Nov. 2, 1866.*

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(SUCCESSORS TO SAMUEL CALLEY. ESTABLISHED 20 YEARS.)
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WORKS: BRIXHAM, TORBAY.

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WOOD GRIDS
FOR
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COWEN'S PATENT FIRE-CLAY RETORTS.
JOSEPH COWEN and CO.,
BLAYDON BURN, BLAYDON-ON-TYNE.

Were the only parties to whom a PRIZE MEDAL was awarded at the GREAT EXHIBITION of 1851, for "GAS-RETORTS and other OBJECTS in FIRE-CLAY," and they were also awarded at the INTERNATIONAL EXHIBITION of 1862, the PRIZE MEDAL for "GAS-RETORTS, FIRE-BRICKS, &c., for EXCELLENCE of QUALITY."

J. C. and Co. have been for many years the most extensive Manufacturers of Fire-Clay Retorts and Fire-Bricks in the Kingdom. Orders for Fire-Clay Retorts of all shapes and dimensions, and to fit any shaped Mouthpiece, Fire-Bricks, and every other article in Fire-Clay, are promptly executed at their Works as above.

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Coal Office,
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JOS. COWEN & Co. are the only Manufacturers of FIRE-BRICKS and CLAY RETORTS at BLAYDON BURN.

JOHN RUSSELL AND CO.,
THE WEDNESBURY TUBE-WORKS, WEDNESBURY;
AND
THE ALMA WORKS, WALSALL.
Established at the commencement of Gas Lighting.

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35, 36, 37, & 39, GRANBY ROW, MANCHESTER.

J. R. and Co. are the original manufacturers of Wrought-Iron Gas Tubes and Fittings, and Inventors of the LAP-WELDED TUBES for Locomotive and Marine Boilers.

J. R. and Co. make all kinds of Tubes and Fittings for Gas, Steam, and Water; Gun-Metal Cocks, Stocks, and Dies; Galvanized Tubes and High-Pressure Tubes, &c.

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OF
FIRST-CLASS MATERIALS & WORKMANSHIP;
ALSO, STATION-METERS, PRESSURE-GAUGES, STREET-LAMPS, REGULATORS, &c.

ESTABLISHED 1830.

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MANUFACTURERS OF
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CAST & WROUGHT IRON TANKS FOR DITTO,
And Gas Apparatus of every Description.
Marine, Tubular, Cornish, Plain, Furnace, Saddle, and Range Boilers.
SUGAR, SALTPETRE, AND ALL KINDS OF PANS.
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RETORT-SETTING A SPÉCIALITÉ.

RETORTS SET, AND GUARANTEED TO BURN OFF A CERTAIN AMOUNT OF COAL OR ELSE NO MONEY TAKEN FOR THE CONTRACT.

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Retort-Setters sent to all parts of Europe and America
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NATIONAL STANDARD GASOMETERS

FOR THE ENGLISH GOVERNMENT
AND FOR THE GOVERNMENT OF THE NETHERLANDS
AND OF THE DUPLICATE COPY
Presented by Her Majesty's Government to the French Government,
AND MANUFACTURERS OF

IMPROVED DRY GAS-METERS

Warranted to Measure correctly & not to vary.

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MANUFACTURERS OF

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LAP-WELDED IRON AND HOMOGENEOUS METAL BOILER TUBES.

Boiler-Tube Ferrules, Gun-Metal Gland Cocks, Water-Gauges, Whistles, &c.; Stocks, Taps, and Dies for Screwing, and Gas-Fitters Tools.

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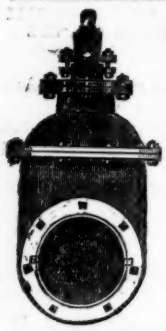
MANUFACTURER OF

EVERY DESCRIPTION OF TUBING, GAS, STEAM, HYDRAULIC TUBES AND FITTINGS,
EITHER BLACK, GALVANIZED, OR ENAMELLED HOT WATER TUBES AND FITTINGS,
CORE BARS, COILS, COCKS (IRON OR BRASS),
CHANDELIERS, &c., GAS-FITTERS' TOOLS, GAS TONGS, STOCKS, TAPS, DIES, &c., &c.,
HANDRAIL TUBINGS, IRON AND BRASS, PLAIN OR TWISTED,
TELEGRAPH TUBES OR POLES, &c., &c.



C. & W. WALKERS' DOUBLE-FACED GAS-VALVES.

These solidly constructed double-faced Gas-Valves have taken the place of the old system of the light, single-faced disc, which is too uncertain and unreliable in large bores.

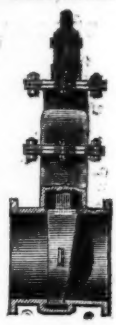
They are guaranteed absolutely gas-tight. They are very massive and rigid, and by improved modes of manufacture they are produced at very little excess in cost over the old light, weak system, which is liable to spring and bend, and become leaky.

The Valve is a rigid wedge of solid cast iron, having two perfectly scraped surfaced facings fitting between the two on the body, which are also surfaced.

A spring in two short halves, and, therefore, not liable to break, is used only for scraping the front facing clean.

The front facing is vertical; the back facing forms the wedge.

At a slight additional expense both flanges are faced to bolt to main-pipes.



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DONNINGTON, near NEWPORT, SHROPSHIRE; 8, FINSBURY CIRCUS, LONDON.

THE LANCASHIRE GAS-METER COMPANY,

LIMITED,

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MANUFACTURERS OF

WET & DRY GAS-METERS, GOVERNORS, PRESSURE & EXHAUST REGISTERS,

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STREET-LAMP METERS in CAST-IRON CASES.

LAMP COCKS AND BRASS FINISHING IN ALL ITS BRANCHES.

TRADE MARK

THE MEDAL FOR 1862.

The only Prize Medal awarded for TUBES & FITTINGS.

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WAREHOUSE: SOUTHWARK STREET, LONDON.

JAMES RUSSELL & SONS, LIMITED,

PATENTEES & FIRST MAKERS OF WROUGHT-IRON TUBES,

ONLY MAKERS OF HOMOGENEOUS METAL TUBES.

MANUFACTURERS OF

TUBES and FITTINGS for GAS, STEAM, and WATER;
LAP-WELDED, LOCOMOTIVE, MARINE, and other BOILER TUBES;
HYDRAULIC TUBES, BEDSTEAD TUBES, WELL TUBES, TELEGRAPH POSTS, COILS, &c.;
GAS-FITTERS TOOLS, VALVES, COCKS, &c.

THOMAS PIGGOTT & CO.,

(Established 1822,)

SPRING HILL, BIRMINGHAM.

MANUFACTURERS OF

TELESCOPIC & SINGLE GASHOLDERS,

CAST & WROUGHT IRON TANKS FOR DITTO;

PURIFIERS, CONDENSERS, SCRUBBERS, RETORTS, VALVES;

IMPROVED WROUGHT-IRON RETORT-LIDS, CROSS-BARS, & SCREWS;

AND GAS APPARATUS OF EVERY DESCRIPTION.

SOLE MANUFACTURERS OF LIVESEY'S PATENT GASHOLDER MAN-LID,

By use of which Man-lid, inlet and outlet pipes can be ex[illegible] and cleansed without loss of gas in crown of holder, or ingress of a[illegible]heric air.

ROOFS, GIRDERS, BRIDGES, AND BOILERS OF ALL KINDS.

Drawings, Specifications, and Estimates supplied on application.

London Agent: W. G. DAVIS, 2, BRABANT COURT, PHILPOT LANE, E.C.

1862.

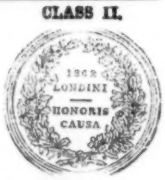
PATENT ANTIMONY PAINT.

MADE ONLY BY

GEORGE HALLETT & CO.,

296, ROTHERHITHE, LONDON, S.E.

CLASS II.



This Paint having been in general use over fourteen years (especially in some of the principal Gas-Works), and proved itself the best light-coloured Paint produced for resisting the influence of vitiated atmospheres, it is important that its qualities should be more widely known.

It is not discoloured like white lead in a sulphuretted atmosphere, nor washed off like white zinc; and its light colour reflecting heat, produces much less expansion of gas in holders painted with it than with dark colours, besides rendering them much more sightly. Its specific gravity is so much below white lead that the same weight will cover one-third more surface, while it is equal in body; and its price being about the same (30s. per cwt.), it is actually one-third cheaper. From experience, its manufacture is greatly improved, and it is quite suitable for all purposes in which white lead is employed.

The following Gas Companies in London have used the Paint for years—viz., The Gaslight and Coke, Imperial, Independent, City of London, Commercial, London, and Surrey Consumers.

N.B.—Antimony Paint, COVERING SO MUCH MORE WORK, costs about 20s. per cwt., as compared with White Lead at 30s. per cwt.; a similar economy arises from its use in Steam and Gas Joints, for which purpose it is superior to White Lead.

SPECIAL DRIERS FOR ANTIMONY PAINT SUPPLIED.

GAS PURIFICATION & CHEMICAL Co., LIMITED.

(Successors to JOHN WILLIAM O'NEILL & CO.,)

Offices—PALMERSTON BUILDINGS, OLD BROAD STREET, LONDON, E.C.,

CONTRACTORS FOR GAS PURIFICATION BY OXIDE OF IRON.

The superiority of the material supplied by this Company is generally recognized, and it is now in use in nearly all the London and most of the large Provincial Gas-Works.

JOHN WILLIAM O'NEILL, SAMUEL H. JOHNSON, } Joint Managing Directors.

Established

1795.

JOSEPH CLIFF & SON,

THE ORIGINAL

WORTLEY FIRE-BRICK WORKS,

NEAR LEEDS,

MANUFACTURERS OF ALL DESCRIPTIONS OF

FIRE GOODS, and Salt-Glazed Drain-Pipes.

LONDON WHARF:

Wharf No. 4, inside Great Northern Goods Station, King's Cross, N.;

LIVERPOOL—1, Back Leeds Street,

Where is always kept a Stock of Retorts, Fire-Bricks, Terra Cotta Ware, and Drain-Pipes.

THE

IMPERIAL METER COMPANY,

LIMITED,

KING'S ROAD, LONDON, N.W.,

OFFICE: 115, VICTORIA STREET, WESTMINSTER, S.W.,

MANUFACTURERS OF

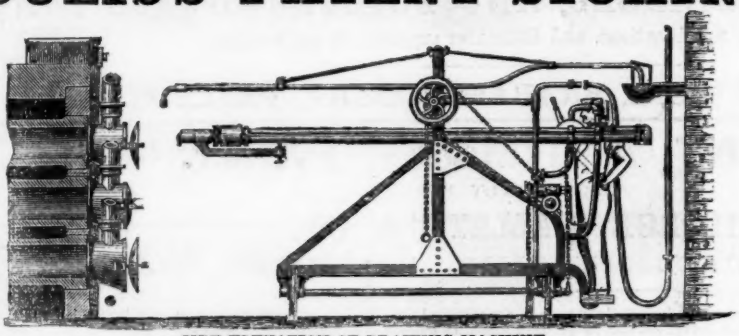
"WET" & "DRY" GAS-METERS IN IRON & TIN-PLATE CASES,

STATION-METERS AND GOVERNORS, STREET-LAMP METERS, BOXES, AND REGULATORS FOR THE AVERAGE METER SYSTEM.

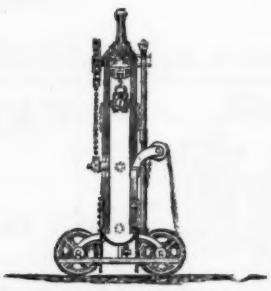
Attention is called to their Dry Meters in Wood Cases, as used by the principal London Gas Companies. These Meters are especially suitable for seaport towns and for export.

The Company repair or convert every description of Wet Gas-Meters to De Castro and Burton's Patent.

FOULIS'S PATENT STOKING MACHINE.



SIDE ELEVATION OF DRAWING MACHINE.



END ELEVATION.

(The Charging Machine will be Illustrated in next week's Advertisement.)

Makers: TANGYE BROTHERS and HOLMAN, London and Birmingham; ADAM WOODWARD and SON, Manchester; ROBERT LAIDLAW and SON, Glasgow; MASCHINENBAU-ACTIEN-GESELLSCHAFT HUMBOLDT, Kalk bei Deutz; Or all particulars may be had from JAMES WOTHERSPOON, 31, St. Vincent Place, Glasgow.

JOHN WRIGHT AND CO., ESSEX WORKS, BIRMINGHAM,

Beg to call the attention of MANAGERS and DIRECTORS of GAS COMPANIES to the following letter which they have lately received.

COPY OF LETTER RECEIVED FROM MAGNUS OHREN, Esq.

Crystal Palace District Gas Company, Lower Sydenham, S.E.

To Messrs. John Wright and Co., Essex Works, Birmingham.

Dear Sirs,—In reply to your inquiries, I am glad to state that the use of GAS COOKING AND HEATING STOVES has been a complete success here. We have several hundred in use in our districts. We also find it advantageous to let out Stoves at a small rental. We have now 275 Stoves at rent.

The Stoves you make I can with confidence recommend, having so many in use, and giving satisfaction. I need scarcely point out to you the advantage to Gas Companies to recommend the use of Gas Stoves to their Gas Consumers, even where they do not supply them on sale or rent, as the use of Gas Stoves brings day consumption, and thus the Company make a profit by day as well as by night.—I am, dear sirs, yours faithfully, MAGNUS OHREN.

Size, 26½ in. high; 14 in. wide; 12½ in. back to front.

Price 50s., complete with Pan and Gridiron.

GAS HEATING STOVES

(TERRA COTTA AND IRON).

THE CHEERFUL STOVE.

COOKING STOVES.

BREAKFAST COOKERS.

BATHS HEATED by GAS

GAS STOVES

For Boiling, Broiling, Preserving, Heating Flat Irons, and for all other Domestic Purposes.

Gas Companies and the Trade who have not our Illustrated Catalogue are respectfully requested to apply for same.

A LIBERAL DISCOUNT to the TRADE.

No. 4003.

THE CHEERFUL GAS STOVE, with Copper Reflector,

Has all the appearance of a Bright Fire.

PRICE from 32s.

WILLIAM SUGG,

GAS ENGINEER,

VINCENT WORKS, VINCENT STREET,

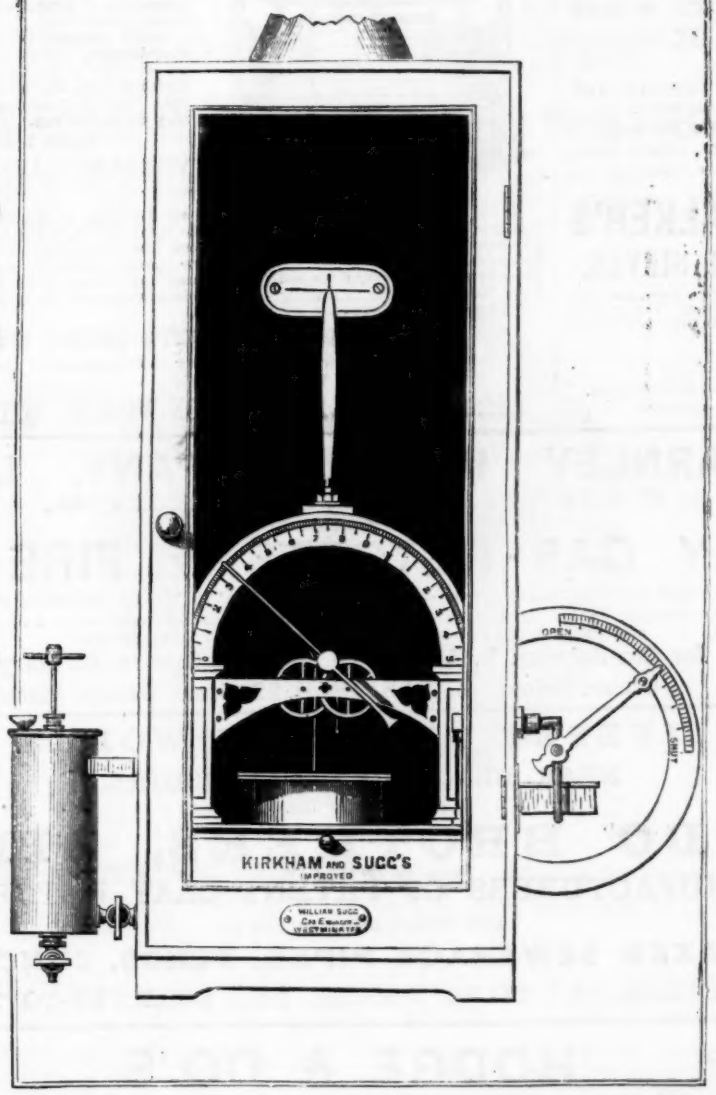
WESTMINSTER, S.W.

"EVANS"

Photometers,

which do not require a Dark Room, with every Fitting accurately made to Gauge, French Polished Bench and Drawers complete, as approved by the Gas Referees.

LOWE'S JET PHOTOMETER.



"LETHEBY"

Photometers,

with Fittings and Bench complete for Dark Room, as approved by the Gas Referees.

LOWE'S JET PHOTOMETER

(KIRKHAM AND SUGG'S IMPROVEMENTS),

With new external Water-Line Regulator; Improved Micrometer, with Quadrant divided into 45 degrees; Valve, with *pro ratâ* opening; Improved Ventilator, Purple Glass Height of Flame Measurer; King's Gauge, working on Friction Rollers. In French Polished Pine Case. Diagram for ditto for finding the Illuminating Power in Candles.

PRICE £12 10s. COMPLETE.

Can also be had with additional Scale on Pressure Gauge, to show by inspection the Illuminating Power in Sperm Candles, at a slight extra cost.

NOTE.—When an order is given for a Jet Photometer with this latter addition, it will be necessary to state about the quality of Gas for which it will be used. The range in candles will not be more than three or four.

PRICE LISTS WILL BE FORWARDED POST FREE ON APPLICATION.

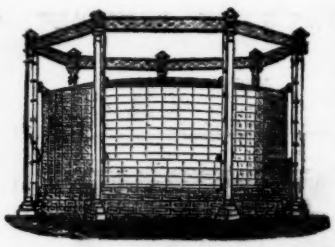
PLUTONIC CEMENT,
For Repairing Gas-Retorts in Action, preventing Porosity, and reducing the Deposit of Carbon, is highly commended.
WILLIAM RICHARDSON,
GAS AND HYDRAULIC ENGINEER,
CHARLES HENRY STREET AND BISSELL STREET,
BIRMINGHAM.

INTERNATIONAL EXHIBITION, 1862.
CLASS X.
PRIZE MEDAL
For excellence of Fire-Clay Gas Retorts, and "HONOURABLE MENTION" for good quality of Fire-Bricks.
WILLIAM STEPHENSON & SONS,
THROCKLEY,
NEWCASTLE-ON-TYNE.

MOBBERLEY & PERRY,
FIRE CLAY and BRICK WORKS
STOURBRIDGE.
Proprietors of
BEST GLASS-HOUSE POT and CRUCIBLE CLAY.
Manufacturers for Home and Export.
GAS-RETORTS, GLASS-HOUSE FURNACE,
BLAST-FURNACE, TANK BRICKS, LUMPS, TILES,
And Every Description of Best Fire-Bricks.

C. & W. WALKER'S
WOOD PURIFIER SIEVES,
Which have now been used for fifteen years, and their advantages and durability fully established. They are made entirely by steam machinery in very large quantities at the most moderate cost.
MIDLAND IRON-WORKS,
DONNINGTON, NEAR NEWPORT, SHROPSHIRE.
8, FINSBURY CIRCUS, LONDON.

SAM. CUTLER & SONS,
CONTRACTING GAS ENGINEERS,
GASHOLDER & GENERAL GAS APPARATUS MAKERS,
MANUFACTURERS OF
BOILERS, IRON ROOFING, IRON BRIDGES,
AND GENERAL IRONWORK.



S. C. AND SONS undertake Contracts of any magnitude for the **Erection of new and Remodelling of existing Gas-Works**, for **Gasholders, Cast and Wrought Iron Tanks, Iron Roofs**, and every description of **Apparatus** for the Manufacture and Distribution of Gas.
Special attention is invited to their **"Improved Condenser,"** which is very effective, and much approved; also to their patterns of **Annular** and other **Condensers, Scrubbers**, and **Purifiers**, of all sizes, which they arrange either with **Centre** or Ordinary **Slide Valves.**
WORKS FOR THE SUPPLY OF
VILLAGES, MANSIONS. FACTORIES, &c.

S. C. AND SONS undertake the **Supply** and **Laying** of **Mains** for **Gas and Water**, and supply all Castings, Connexions, and Fittings for Retort-House, Works generally, and for Streets. They also supply **Valves** of all descriptions, Iron and Clay Retorts, Hotpressed Retort-Lids, Steel Charging-Scoops of improved make, for which they have special machinery, Improved Coke and Coal Barrows, Cross-Bars and Screws, Bolts and Nuts, Furnace and Stoking Tools, Iron and Wood Purifier-Sieves, Lead, Yarn, Borings, &c., including every requisite whatsoever for a Gas-Work, a well-assorted stock being kept of those goods most in request.
SOLE MAKERS OF BRETT'S PATENT COKE BARROW.
Experienced Retort Setters sent to any part of the Kingdom.
Address: **PROVIDENCE IRON-WORKS, MILLWALL, LONDON.**

THE FARNLEY IRON COMPANY, LIMITED,
FARNLEY, near LEEDS,
MANUFACTURERS OF
FIRE-CLAY GAS-RETORTS & FIRE-BRICKS,
Of every size and shape, and of the best quality; also of White and Coloured GLAZED BRICKS, SANITARY PIPES, &c., &c.
In order to meet the constantly increasing demand for their Gas-Retorts, the F. I. Co. have recently made such an addition to their premises as will enable them to execute expeditiously the largest home or foreign orders.
London Agent for Gas-Retorts: **D. W. OGG, 3, Jeffrey's Square, St. Mary's Axe, E.C.**
" " Glazed Bricks: **A. BARFIELD, 22, Great George Street, Westminster.**

LIVESEY FIRE-CLAY WORKS.
NEAR BLACKBURN, LANCASHIRE.
(ESTABLISHED 1835.)
ORLANDO BROTHERS, LIMITED,
MANUFACTURERS OF PATENT CLAY RETORTS,
AND EVERY DESCRIPTION OF
TUBULAR GLAZED SEWERAGE PIPES, BENDS, JUNCTIONS, ETC.
FIRE-BRICKS, TILES, BLOCKS, AND CHIMNEY-TOPS

HODGE & CO.'S
IMPROVED VENTILATING SUN-LIGHTS
WITH TALC REFLECTORS AND SELF-ACTING VALVES
TO PREVENT DOWN-DRAUGHT;
VENTILATING GLOBE LIGHTS for DINING-ROOMS, LIBRARIES, &c.
Ormolu, Bronze, & Crystal Gaseliers;
MEDIÆVAL CHURCH WORK AND CORONÆ
COCKS, VALVES, and FITTINGS for GAS, STEAM, and WATER;
COLUMNS, BRACKETS, & STREET LANTERNS;
BLACK AND GALVANIZED BARREL COMPO AND TIN PIPE.
GAS ENGINEERS,
100, HATTON GARDEN, LONDON.

Drawings and Prices upon application.

TANGYE BROTHERS AND HOLMAN,

LAURENCE POUNTNEY LANE, LONDON, E.C.,

SOLE MAKERS OF

MORTON'S PATENT SELF-SEALING

RETORT-LIDS,

WITH

HOLMAN'S NEW PATENT

BRACKETED CROSS-BARS,

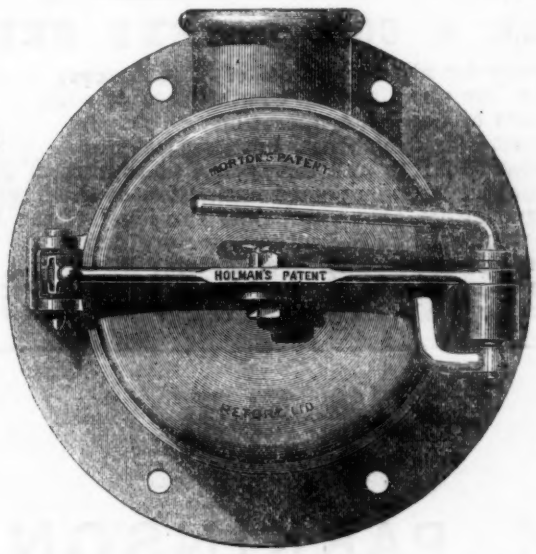
ANTI-FRICTION CATCHES, AND ECCENTRIC FASTENINGS.

NO LUTING.

NO DUPLICATE LIDS REQUIRED.

INSTANTANEOUS SEALING EFFECTED.

VERY DURABLE.



HOLMAN'S NEW SELF-SUSTAINING CROSS-BAR ENSURES FREEDOM OF JOINT, AND MAINTAINS PARALLEL POSITION OF THE LIDS.

By the employment of MORTON'S PATENT SELF-SEALING RETORT-LIDS, with HOLMAN'S PATENT ECCENTRIC FASTENINGS, the old-fashioned, cumbersome, and expensive method of sealing Retorts, by luting the lids with lime and other materials, is entirely dispensed with.

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" Gaslight Co., Silvertown.
" Gaslight Co., Lupus Street.
" London Gaslight Co.
" Independent do.
" Phœnix do.
" South Metropolitan Gaslight Co.
" Commercial do.
" Imperial do.
" West Ham Gas Co.
" Gas-Works, Barnet.

The Gas-Works, Royal Arsenal, Woolwich.
" do. Lower Sydenham.
" do. Brentford.
" Consumers Gas Co., Woolwich.
" Alliance and Dublin Gas-Works.
" Edinburgh do.
" Manchester Corporation do.
" Salford do. do.
" Rochdale do. do.
" Liverpool Gas-Works.
" Birmingham do.
" Birkenhead do.
" Nottingham do.

The Newcastle-on-Tyne Gas-Works.
" Lurgan do.
" Carmarthen Gas-Works.
" Merthyr Tydfil do.
" Windsor do.
" Leeds do.
" St. Albans do.
" Over Darwen do.
" Rotherham do.
" Aylesbury do.
" Bournemouth do.
" Ystrad do.
" Cardiff do.
" Rochester do.

The Keighley Gas-Works.
" Aberdare do.
" Ballymena do.
" Richmond do.
" Stalybridge do.
" Longton do.
" Exeter do.
" Ross do.
" Falmouth do.
" Barrow-in-Furness do.
" Belfast do.
" Wakefield do.
And other Provincial and Foreign Gas-Works.

IMPORTANT TESTIMONIAL.

The Gaslight and Coke Company (Commonly called the Chartered Gas Company), Beckton, North Woolwich, July 2, 1874.

MESSRS. TANGYE BROTHERS AND HOLMAN.

Gentlemen,—In answer to your inquiry respecting the Self-Sealing Lids, I beg to say that they continue to work well, and I have every reason to be satisfied with them.

I should be very sorry to return to the old system of Luting, and our stokers here freely acknowledge the benefit to them of the new system.

I am, yours truly,
(Signed) G. C. TREWBY.

London 1851. New York, 1853 Paris, 1855. London, 1862.

Dublin, 1865

The SIX MEDALS AWARDED to THOMAS GLOVER for

PATENT DRY GAS-METERS,

The latter being the Highest Medal awarded for Dry Gas-Meters by the Imperial Commissioners for the Universal Exhibition, Paris, 1867.

Paris, 1867.

THOMAS GLOVER & CO.,

DRY GAS-METER MANUFACTURERS,

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METERS FOR MEASURING WATER.

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NOTICE TO SUBSCRIBERS.

Subscribers who desire to avail themselves of the reduction in the subscription to the JOURNAL by paying in advance for the second half of the year 1876, are reminded that this can only be done during the present month.

THE JOURNAL OF GAS LIGHTING,
WATER SUPPLY, & SANITARY IMPROVEMENT.

TUESDAY, JULY 11, 1876.

Circular to Gas Companies.

IT may sound paradoxical if we remark, that the parliamentary proceedings, with reference to the Metropolitan Gas Question, during the past week, have been of importance, and yet not of much consequence. In the first place, and in the case of the Board of Trade Bill, Metropolis Gas (Surrey Side), which was referred to the Examiner, it would seem that Mr. Wyatt has been caught napping, for the Examiner has reported that the Standing Orders have not been fully complied with. This, by itself, is of no great consequence. The Bill, and the report of the Examiner, will now be referred to the Committee on Standing Orders, who may, or may not, report that in this instance strict compliance with the Orders need not be enforced. The result, whatever it may be, is, we imagine, now of little moment. It is far too late in the session for the Bill to be proceeded with much further, and in any case we may doubt whether—unless the Government put on all the pressure they are able to exert—the Bill can this session advance beyond a second reading in the House of Commons.

The next thing to be noted is, that the Committee of the House of Lords have passed the Bill of the Chartered Company, striking out, however, the power to purchase the plot of land belonging to the Metropolitan Board of Works, adjoining the Beckton station. It would have been of undoubted advantage to the company to become possessed of the land, but the loss of it only necessitates some alterations in their plans for extensions.

Next, it is to be specially noted, that the South Metropolitan Company have not withdrawn their Bill, but have meekly accepted the three-and-sixpenny initial price; and, further, the vestries of Camberwell and Lambeth withdrew their opposition, and the measure passed pleasantly through committee in the House of Lords.

But the end has not yet come. Camberwell and Lambeth may be satisfied, but Lords Camperdown and Redesdale are not. And here we get rather puzzled. The printed votes of the House of Lords inform us that the Bill of the Chartered Company has passed a select committee with the alteration mentioned above. But on Friday afternoon Lord Redesdale gave notice that he would, at the proper time, move a resolution to the effect that the Bills of the two companies should be referred to a committee of the whole House instead of a select committee. There is, he very correctly said, a considerable difference of opinion as to the merits of the two measures, and he intimated that a select committee could not be trusted to deal with them. As Lord Camperdown was not a member of the select committee who dealt with the Bills—or rather, we should say, the one Bill—he was naturally of the same opinion, and he gave notice that, at the proper time, he would move amendments which he would place on the papers. The Duke of Richmond, too, seemed to be ignorant of the fact that the Chartered Company's Bill had already passed a select committee who had taken evidence, and he recommended that the measure should be sent before such a committee who could hear witnesses. As we said before, we are greatly puzzled. Are the printed papers inaccurate, or do not noble lords take the trouble to read them; and is there no clerk at the table to set blundering peers right? Whatever may be the fact, the upshot, no doubt, will be that the companies Bills will be opposed on the third reading.

Lord Camperdown's objections to the Bill of the Chartered Company are, first, that the new capital asked for by the company—two millions—is too large. He argues that the million of share capital when sold by auction will produce two millions, and the million of loan capital will make three millions. This, he seems to think, is too much money for a company to be allowed to expend. We can assure him, however, that the three millions, whether in the hands of a Company, a Commission, or a Corporation, will only suffice for the wants of a few years, if the Metropolis continue to grow, and the consumption of gas to increase at the present rate. The common calculation, based on the experience of many years, is, that it is necessary to double the capital of a gas company every eight or ten years. The capital already raised by the companies now amalgamated under the name of the Chartered Company, exceeds eight millions, and two millions are now asked for, which may, or may not, produce three millions. Supposing, however, the last-named sum to be raised, it is clear that, according to rule, it will only last the company four or five years, after which, under some authority or other, they must raise further capital.

Lord Camperdown's next objection is, that the initial price of 3s. 9d. is calculated to enable the company to pay a dividend of ten per cent. which he thinks much too high a rate. The noble lord's notions on the matter of capital and dividend are, however, so very hazy, that we can hardly combat his opinions. He is made to say that, if capital be raised at ten per cent., it will, if sold by auction, command a premium of 100 per cent. That is possible, although *we* shall not pay 100 per cent. premium for shares, the profits on which are to be regulated by a sliding scale. Supposing, however, the shares to command the premiums named, and ten per cent. to be divided, it is clear that the shareholder will only receive five per cent. on his investment, for the sum paid by way of premium will not be entitled to dividend. As a matter of fact, proprietors who have bought their shares in the market during the last ten years get only about five per cent. for their money. They have, of course, gained something by the issue of new capital after they became proprietors, and, as we pointed out some weeks ago, the prospect of participating in new issues was an important element in settling the price of shares. When the auction clauses come into force, together with the sliding scale, we shall be greatly surprised if shares command a premium of 100 per cent. We have before pointed out, that the initial price of 3s. 9d. is not calculated to ensure a ten per cent. dividend, until dividend-bearing is largely diluted with non-dividend-bearing capital profitably employed. It will be many years before such a state of things can be brought about.

Our respect for the House of Lords prevents us from saying that the peers who took part in the discussion on Friday afternoon, assisted in the performance of a farce, which might be entitled "All in the Wrong;" but we must point out one curious misrepresentation, made, we are quite certain, unintentionally, by the Duke of Richmond. He said that the initial price of 3s. 9d. was fixed by Lord Cardwell's committee. In one sense, the statement was quite true; but it should have been mentioned that, with this initial price was coupled the revision clauses, which guaranteed ten per cent. Three-and-ninepence with revision clauses, and the same price with the sliding scale, are very different things, as gas shareholders will find out when another coal famine occurs. We shall await, with much curiosity, the amendments Lord Camperdown will propose.

The Metropolitan Board of Works, seeing clearly, perhaps, that the Regulations Bill is dead, have been devoting some attention to the Metropolis Gas (Surrey Side) Bill. In this they find little that is objectionable, but they are bound to find fault. In the first place, they complain that the 5th section of the Gas-Works Clauses Act, 1871, has not been incorporated in the Bill. The

section referred to prohibits a gas company from storing gas on any land they may acquire by agreement, except with the consent of the owners and occupiers or lessees of every dwelling-house within 300 yards of the site. The Board of Trade very properly argue that it would be useless to give companies power to buy land unless they had, also, power to make use of it. They might also have urged that, circumstanced as we are in this Metropolis, the consent of the parties interested would in all cases have to be purchased, and thus large costs would be levied on the companies. The Metropolitan Board, however, insist that the proviso shall be inserted, and it remains for the Board of Trade to decide. We are not sufficiently acquainted with the practice of Parliament, but we have some suspicion that it is on this very point that the Examiner has rejected the Bill. The Standing Orders of both Houses of Parliament require the insertion of such a proviso in every special Gas Act, but whether or not the Order will apply to a *quasi* public Act like that under notice, we do not know.

Another thing the Metropolitan Board object to is the general powers of amalgamation which the Act, if passed, will confer. They wish to confine the power to unite, to the three companies specially concerned with this Bill—the London, Phœnix, and Surrey Consumers—excluding the South Metropolitan. The Bill promoted by the last-named company, if passed, will confer a general power to amalgamate with any company; but then the Metropolitan Board know very well that no company can possibly combine with the South Metropolitan, restricted to an initial price of 3s. 6d. The effect of this obstructive policy of the Board, if it should prove successful, will be to drive the South Metropolitan Company into the arms of, what we may call, a three-and-ninepenny company, while the policy followed by the company named, tends to deprive them of any claim to a preferential dividend if they eventually decide that it is to their interest to amalgamate.

On another point we are glad to have to acknowledge that the Metropolitan Board have acted with great fairness. One provision in the "Surrey Side" Bill is intended to allow the Surrey Consumers and London Companies to make up their reserve-funds to the statutory amount. This, as we pointed out a week or two ago, when first noticing the Bill, must necessarily, if allowed, keep gas at the initial price, and delay the operation of the sliding scale for a year or two. The Metropolitan Board at first protested, but, on further consideration, they have seen the fairness of the proposal, which they now admit, or rather consent to, in the hope that the admission may lead to some settlement in this session.

Candidly speaking, we do not expect any settlement of the Metropolitan Gas Question this year. The Bills of the Chartered and South Metropolitan Companies may possibly pass, but even this is doubtful. The fate of the "Surrey Side" Bill is even more doubtful, and we shall not regret if it fall through. The interval which will occur between the present time and next session may be well spent by the companies in considering how they may combine, so as to save themselves from the clutches of a Commission or some sort of Corporation. On the other hand, the Board of Trade will have time to elaborate a scheme which will ensure uniformity of gas legislation all over the Metropolis. The case of the Commercial Company presents a difficulty, but it may be met. It will be strange indeed if this company be left to raise new capital without the auction clauses, to which all others must submit. The Corporation of London consulted Mr. Tarbotton, of Nottingham, on this point, and the Board of Trade became converted to these clauses too late. It must, however, occur to every mind, that metropolitan gas legislation cannot be left in a fragmentary state. Nothing but uniformity can endure. The gas companies can bring this about for themselves. If they do not, it may be taken as certain that some extraneous power will step in and compel it.

In our notice of the Correspondence of the Board of Trade with the ex-Referees, last week, we made two mistakes. First, we find that the original salary of the Referees was not, as we said, £400 a year, but £600, to which another hundred was subsequently added. The correction somewhat affects our argument, for we are inclined to think that a gentleman, especially if a bachelor, may exist comfortably on £700 per annum. That, however, may be a matter of opinion.

Next, Mr. J. S. Peirce writes to say that he has not, and never has had, any relation or connexion with Dover, either by family, business, or politics, so we have to apologize and explain. Our newspaper reading has shown us that in all Conservative demonstrations at Dover, a Mr. John Sampson Peirce takes a prominent part, and, if our memory serves us, a gentleman of that name proposed one of the present members of Parliament at the last election. The existence of two gentlemen of the same name was calculated to mislead, the more so as it was generally believed at the time that the original appointments were, in part, rewards for political services.

The accounts of the Liverpool United Gas Company will be brought under the notice of the Recorder at the next borough sessions, when, we understand, evidence will be offered on the part of the Corporation, with a view to bring about a reduction in the price of gas. The proceedings, to which we have before referred, are taken under the thirty-fifth section of the Gas-Works Clauses Act, 1847, and will possess unusual interest. The inquiry, we imagine, will be of exactly the same kind as would have taken place, if the London authorities had endeavoured to put the revision clauses of the Acts of 1868-9 into operation, against the Chartered and Imperial Companies.

The Scottish Corporations are now publishing their gas accounts, which, so far as we have seen, offer a very favourable appearance. Good profits have been made at Paisley, Forfar, and Arbroath, and there is a prospect of a reduction of price in the former places. At Arbroath the Commissioners made a loss on the undertaking the year before last, which is, however, nearly covered by the profit made in the past year.

The able paper by Mr. W. Richards, on "The Theory of Retort-Settings," which we publish to-day, will, we are certain, be studied with attention. The profits of a gas company are made in the retort-house, and everything that promises a reduction in the cost of carbonization is worthy of serious consideration. Under the circumstances, we cannot say more on the paper.

Water and Sanitary Notes.

We much regret to announce that the Stockton and Middlesbrough Corporations Water Bill has been passed by a Select Committee of the House of Lords. It must be remembered, that this is the first measure involving downright confiscation which has received the sanction of Parliament, and, as such, the precedent must be viewed with alarm. For the future, no water company can consider themselves safe in the possession of their property, in face of a Corporation. What the immediate effect of this success may be, we cannot say; but we have before quoted a remark made by a partisan of the Corporations, in the lobby of the House of Commons, to the effect that, if this Bill passed, all the Corporations in the kingdom would go in for water-works next year. We do not anticipate any such general rush, but we have no doubt it will encourage many local authorities who have hitherto hesitated, to promote Bills for the acquisition of gas and water undertakings. We may, however, warn them that the decisions of Parliamentary Committees are singularly capricious. No doubt they are, to a certain extent, dictated by precedent; but, then, all other precedents are opposed to the principle affirmed in the decision on the Stockton and Middlesbrough Bill, and the next Corporation who go to Parliament to acquire a water undertaking against the wishes of the proprietors, may find themselves rudely set aside. So much by way of caution to ambitious local authorities, to which we need only add an expression of opinion, that this Bill had a very narrow escape in the Lords Committee, the members of which were by no means unanimous as to its merits. Probably, the decision was dictated by the fact, that the terms of purchase are, as we may admit, sufficient, and, some would say, liberal. Twenty-five years purchase of dividends, with a sum (to be settled by arbitration under the Lands Clauses Consolidation Act) for prospective profits, are, it may be conceded, not bad terms. Still the company did not wish to part with their property, and the simple fact is, that it has been confiscated. The Corporations have now their "White Elephant," and we shall see, in the course of a few years, whether the possession of that sacred animal is beneficial to them or not. They are bound to the construction of a portion of the new works they have projected, within the next four years. Before that time has elapsed, we expect that the Corporations will apply to Parliament for an extension of time; and meanwhile, and for many years to come, only the much-abused supply from the Tees will be drawn upon.

We announced, last week, that an agreement had been come to between the Water Company and Corporation of Wakefield, by which the latter would acquire the water undertaking for about £200,000. Some hitch, we believe, has since occurred in the negotiations; but the resolution of the Town Council, reported in another column, would appear to have decided the matter. Of course the resolution of the Council agreeing to purchase may be rescinded; but the session is fast ebbing away, and if anything be done, it must be done at once. We showed, last week, that the Corporation have to pay £30,000 for law and parliamentary expenses incurred by the Company in past years. This year it seems that a further debt of £10,000 has been incurred on the same account, and another contest next year will probably entail a similar expenditure, all of which the Corporation will have to pay (in addition to their own costs) whenever they complete the purchase. Let us hope, however, for the sake of both parties, that the bargain agreed to will be ratified. The proceedings before

the Select Committee of the House of Lords have been adjourned for a fortnight, to afford an opportunity for completing the desired arrangements.

Liverpool is still greatly exercised on the water question, and Mr. Alderman Bennett has started a new idea. He estimates that the manufacturers raise fifteen million gallons of water per day from their private wells. He proposes to collect as much of this as he can, and, pumping it to a convenient reservoir, make use of it for baths and wash-houses, street watering, and the flushing of sewers, &c., &c.—that is, for any purpose other than domestic use. The idea is ingenious, but, we fear, impracticable. The worthy alderman makes the assertion, that the sewage of the town of Rivington flows into the reservoir of that name. We hope he is mistaken. In the meantime, scientific authority is condemning the water of some of the wells, which appears to be now "contaminated," and may be still more so if a larger quantity be pumped.

Speaking of Liverpool reminds us that some weeks ago we noticed a circumstance which met with local approbation—viz., that some practical farmers had been elected on the Local Board of West Derby, under whose advice it was hoped that the sewage farm would be profitably managed. These gentlemen have dissipated the hope, at all events for this year. They anticipate that the loss in the past (£2000) will be exceeded in the present year. But for this they do not hold themselves responsible. They were elected after the present crops were in the ground, and these are not such as they approve. They have a great opportunity before them, and we wish them every success next year. We agree with them, however, that the first thing to do is to get the accounts of the farm to rights.

The Local Board of Twickenham, after talking and travelling for eight years, have, at last, decided on a plan for the purifica- of their sewage before it enters the Thames. We suppose it is an isolated scheme. The decision is opportune, for, as our readers know, the Thames Conservancy Board are about to put the Act in force, which inflicts a penalty of £50 a day on local authorities who pollute the Thames with sewage.

We have, at times, informed our readers of the attempts made to effect the combined drainage of the Pottery Towns, which send their sewage into the Trent. The several local authorities have, however, failed to agree to a general scheme, or, indeed, to any scheme at all. The Duke of Sutherland now takes the matter in hand, and gives notice to the Local Board of Burslem, that he intends to take proceedings, unless they at once decide on adopting some system for the purification of their sewage. The hint, probably, will not be lost on Stoke and other towns.

Nottingham also is concerned, just now, with the insoluble sewage question. We regret that the lengthy proceedings, at the last meeting of the Town Council, prevent us from saying more than that, they have resolved to inquire further before they spend more money on a sewage farm.

The Corporation of Birmingham have been rejoicing over their possession of the water undertaking, and Mr. Alderman Avery "chaffs" the Corporation of London at their not having secured the Metropolis water undertakings years ago, when they might have been had for less than half the price they command to-day. His remarks were wasted. He does not know the Corporation of London so well as we do.

The proceedings taken by the New River Company against occupiers, reported in another column, are of some importance. The question as to what constitutes a supply of water for "domestic purposes" appears to be settled; but the greater question, as to "annual value," was not raised. This much, however, appears, that the New River Company act very liberally. Premises valued at more than £700 a year are assessed by the company at only £400; and in another case, in which the valuation was £230 a year, the company charged only on £150. After these facts are known, the noise about gross annual value and net value will probably cease.

A TREATISE ON THE SCIENCE AND PRACTICE OF THE MANUFACTURE AND DISTRIBUTION OF COAL GAS.

XCIX.

Composition and Analysis of Purified Gas.

Propylen, *Tritylene*, is always included among the constituents of coal gas, but in what proportion it is present has never been ascertained. It is a colourless gas, condensable by cold and pressure, possessing a somewhat agreeable odour. Its specific gravity is 1·45, and 100 cubic inches weigh 45 grains. It is one of the most valuable of the illuminating ingredients in coal gas, burning with a bright yellow flame, which is said by Dr. Letheby to have three times the length, and three times the illuminating power, of that obtained from ordinary coal gas, burning from an orifice of the same dimension and at the same pressure. Like the last-named hydrocarbon gas, it is absorbed by bromine, and also by fuming sulphuric acid, which, as will be seen hereafter, are employed in determining the amounts of condensable hydrocarbons in gas. An excessive heat decomposes it into marsh gas and carbon, from which fact gas managers will draw a natural inference.

Butylen, *Dietryl*, is also, at ordinary pressures and temperatures, a colourless gas, possessing an agreeable ethereal odour and taste. Like the last mentioned, it may, however, be condensed into a liquid under the influences of cold and pressure. At the standard temperature and pressure (T. 60° Fahr., B. 30 inches) the specific gravity of this gas is 1·935, or nearly twice that of atmospheric air. A hundred cubic inches, therefore, weigh exactly 60 grains. The proportion of this gas in ordinary coal gas has never been determined, but its presence has been satisfactorily ascertained. It contributes largely to the illuminating power of the gas. When burned alone it gives a bright yellow flame, about four times the length, and four times the illuminating power, of that given by average coal gas, burning under exactly similar conditions. Passed through a porcelain tube, heated to bright redness, it breaks up into marshgas, hydrogen, and carbon. Butylen is one of the chief constituents of gas procured from animal and vegetable oils, when these materials are employed in the production of gas, and it was in the liquid produced when oil gas was submitted to pressure, that Faraday first obtained the substance. It is readily absorbed by bromine and fuming sulphuric acid (one volume of the latter taking up 100 volumes of the gas), and, therefore, is one of the illuminating constituents removed from coal gas when either of those bodies is employed in its analysis.

Acetylen, *Ethine*, is, perhaps, the most interesting of all the gaseous hydrocarbons existing in coal gas. The proportion found is exceedingly small, which might be wondered at, seeing the numerous reactions by which it is produced, many of which must take place in the retort. It is, for example, formed when marsh gas, the chief constituent of coal gas, is exposed to a red heat. It is also produced when marsh gas and carbonic oxide, another ingredient in coal gas, are heated together. But, unfortunately, acetylen may be said to be born under conditions in which it cannot continue to exist. When exposed alone to a dull red heat it decomposes to form a number of bodies, among which are found olefiant gas, hydride of ethyl (C_2H_5), benzene, and several other liquid hydrocarbons, with the separation of some carbon and hydrogen. Heated with hydrogen, it is also decomposed, with the formation of olefiant gas, benzene, and a variety of other compounds. And, lastly, when olefiant gas and acetylen are heated together to dull redness, they are reciprocally decomposed to form a number of products. Thus the gas, which, on account of its high illuminating power, it would be most desirable to retain in coal gas, is produced in the retort under conditions which seem to forbid its continued existence, and the wonder may rather be that any escapes the ordeal.

Acetylen is a colourless gas, possessing a peculiar and rather unpleasant odour. Its specific gravity is 0·898, and 100 cubic inches weigh 28 grains. It is freely absorbed by water, which takes up its own bulk of the gas, and that may be one reason why so little is found in purified coal gas. Being of all the hydrocarbon gases the poorest in hydrogen, it burns, as might be expected, with an intensely luminous flame; but since it can only be obtained in small quantity, no actual determination has yet been made of the light it gives when compared with coal gas.

Acetylen is readily removed from coal gas, in company with the bodies named above, by bromine and sulphuric acid; but we have also an easy means of separating it alone, and of obtaining the pure gas for experiment. If a current of coal gas be gently passed through a strongly ammoniacal solution of cuprous chloride, a red-brick coloured precipitate is slowly formed, which consists of acetylide of copper. This may be collected and dried; and then, when warmed with dilute hydrochloric acid, pure acetylen is evolved. If the quantity of gas passed through the copper solution be measured, we have the means of arriving approximatively at the amount of acetylen in the gas.

Some other modes in which acetylen is formed may be briefly noticed. It is remarkable that it can be produced by the direct union of its elements. When carbon points are ignited by a very powerful battery in an atmosphere of hydrogen, a considerable quantity is formed. With 40 or 50 Bunsen's cells, it is said that as much as 10 cubic centimètres can be obtained in a minute. Acetylen is also produced when coal gas is burned with an insufficient supply of air. Every one has recognized the unpleasant odour produced, when gas is burned under such circumstances, as, for instance, when the flame of a Bunsen's burner accidentally burns in the interior of the chimney. This is, in part, the result of the production of acetylen. A proof that acetylen is one of the products of the imperfect combustion is easily obtained by inverting a glass flask over the Bunsen's lamp so burning, and afterwards pouring in a solution of cuprous chloride, whereupon the sides of the flask become covered with a film of the red acetylide of copper. There are several other modes by which acetylen may be produced, but they have no special interest for gas manufacturers.

Acetylide of copper, it must be mentioned, is an explosive compound, and is occasionally found when coal gas is passed for a considerable time through copper pipes. It is exploded by heat, percussion, and friction, and several accidents are recorded, due to its deposition in tubes of copper, employed for the conveyance of gas.

It is probable that we have not exhausted the gaseous hydrocarbons which may be found in coal gas, but the above-named, at all events, constitute the bulk of those bodies present under ordinary circumstances.

We pass on to a notice of the liquid hydrocarbons, whose vapours are present in larger or smaller quantities.

(To be continued.)

Parliamentary Intelligence.

HOUSE OF LORDS.

Monday, July 3.

The Rosstrevor Improvement Bill was reported, without amendment.

The Uppingham Water and the Bristol United Gas Bills were read the third time, and passed.

The Horncastle Gas and the Dewsbury and Heckmondwike Water Bills were read the third time, with the amendments, and passed.

The South Metropolitan Gaslight and Coke and The Gaslight and Coke Company Bills were referred to a select committee, consisting of Lord Blachford (chairman), Earl Cowper, Earl Clarendon, Earl Nelson, and Lord Digby; to meet on Thursday, July 6.

The Lancaster Water and Improvement, the Wakefield Water, the Halifax Water and Gas Extension, and the Cleveland Water Bills were referred to a select committee, consisting of Earl Powis (chairman), the Lord Chamberlain, Earl Ellesmere, Lord Seaton, and Lord Hartismere; to meet on Thursday, July 6.

Tuesday, July 4.

The Oldbury Local Board of Health, the Campbeltown Burgh and Harbour, and the Smethwick Local Board Bills were reported, with amendments.

The West Bromwich Improvement, the Tipton Local Board, and the Colney Hatch Gas Bills were read the third time, with the amendments, and passed.

A petition against the Stockton and Middlesbrough Corporations Water Bill was presented from the Plymouth Dock Water-Works Company.

Thursday, July 6.

A report was read from the select committee on the Lancaster Water and Improvement Bill: "That the committee had not proceeded with the consideration of the bill, having found that the petitioners had no *locus standi* before them."

The Halifax Water and Gas Extension Bill was reported from the select committee, with amendments.

A report was read from the select committee on the South Metropolitan Gaslight and Coke Bill: "That the committee had not proceeded with the consideration of the bill, no parties having appeared in opposition thereto."

The Rosstrevor Improvement Bill was read the third time, and passed.

Friday, July 7.

The Chairman of Committees informed the House that the promoters do not intent to proceed further with the Llandudno Water and Gas Bill during the present session.

The Cleveland Water, and The Gaslight and Coke Company Bills were reported from the select committees, with amendments.

The Lancaster Water and Improvement Bill was reported specially, with amendments.

The South Metropolitan Gaslight and Coke Bill was reported, with amendments.

The following bills were read the third time, with the amendments, and passed:—Dunfermline Water, Tunbridge Wells Gas, Campbeltown Burgh and Harbour, Smethwick Local Board.

The Blackrod Local Board and the Sutton Gas Bills were returned from the Commons agreed to, with amendments, which were considered and agreed to.

THE GASLIGHT AND COKE COMPANY AND SOUTH METROPOLITAN GAS BILLS.

Lord Redesdale intimated that as there appeared to be considerable difference of opinion as to the merits of these bills, he thought it would be advisable that they should be referred to a committee of the whole House, instead of to a select committee in the usual course. At the proper time he should move a resolution to that effect.

The Earl of Camperdown said he approved of the course suggested, and he should in committee move some amendments to the bills, notice of which he would give as soon as possible. It would probably be convenient that he should now state the general objections he had to the measures. With regard to the bill of The Gaslight and Coke Company, his chief objection was, that the company sought nominally to raise an additional capital of £2,000,000, but in reality that increased capital would amount to £3,000,000, because there were already powers to raise £1,000,000 by loan, and this additional £2,000,000 was to be raised by a sale of the shares by public auction. The bill also proposed to fix the initial price at 3s. 9d. per 1000 feet, which would enable the company to pay a dividend at the rate of 10 per cent. This being so, the price of the £100 shares in the open market would be about £200, so that when Parliament were asked to sanction the issue of an additional million pounds worth of shares, they were really adding £2,000,000 to the capital of the company. According to the last accounts they had of these companies, he found that there had been in the spring of this year an amalgamation between The Gaslight and Coke Company and the Independent and Imperial Companies. Before this amalgamation took place, the Imperial Company promoted a bill which asked for a large increase of capital. That bill was, however, withdrawn, and those who opposed it now complained that The Gaslight and Coke Company, having taken over the Imperial, were seeking to obtain the same powers, which they formerly resisted. This he considered was a great hardship upon those who had previously contested the matter. He objected to the proposed large increase of capital, and, if it was intended to expend it in a scheme of total renovation, he was by no means sure that the gas companies were the best bodies to carry such a work out. If the House considered the increase was necessary, he urged that it should be raised by loan, and not by the sale of shares. It had been said that this would be an injury to the companies; but, in the case of those now under review, they were companies with almost unlimited credit, whose shares were quoted on the Stock Exchange, and he therefore could not conceive what injury they would suffer.

The Lord Chancellor said he was sorry to interrupt the noble earl, but it was a serious violation of order to discuss the merits of a bill which was not before the House.

The Earl of Camperdown said he was in the hands of the House, but he had wished merely to indicate the points he desired to raise.

The Duke of Richmond and Gordon said he had not himself liked to interfere in a way which might appear discourteous towards the noble earl, as they had had one or two previous discussions on that matter; but he concurred with the noble and learned lord on the woolsack, that there could scarcely be any course more inconvenient or irregular than that of entering into the merits of a bill not before their lordships, merely upon a notice of motion being given by his noble friend at the table (Lord Redesdale) that on a future day, not yet even fixed, he would ask them to refer those bills to a committee of the whole House. He wished to suggest, before his noble friend at the table made his motion, whether it would not be more convenient that the bills should be referred to a select committee, because there were points in them which could not be discussed in committee of the whole House. It might be necessary to call the parties, and that could best be done by referring the bills to a select committee. As to the initial price of 3s. 9d. fixed by the bills, that was settled by the committee presided over by Lord Cardwell.

Earl Fortescue objected to referring these questions of principle to select committees. That was the express ground upon which the noble earl rested his opposition to these bills.

The Marquis of Salisbury objected to the discussion as irregular, and the subject was then allowed to drop.

At a subsequent period Lord Redesdale gave notice that, on a day to be named, he would move, under Standing Order No. 141, that The Gaslight and Coke Company and the South Metropolitan Gaslight and Coke Bills be referred to a committee of the whole House.

HOUSE OF COMMONS.

Monday, July 3.

The Blackrod Local Board Bill (Lords), as amended, was considered; amendments made; bill to be read the third time.

The Sutton Gas Bill (Lords), as amended, was considered; to be read the third time.

PARLIAMENTARY EXPENSES OF THE METROPOLITAN BOARD.

Mr. Kay-Shuttleworth asked the Chairman of the Metropolitan Board of Works when the returns, ordered on March 22, 1875, of expenditure for five years, and of the parliamentary expenses of the Board, would be presented.

Sir J. M. Hogg: In reply to the question of my honourable friend, I have to state that the return has entailed an enormous amount of labour on the officers of the Board, but is now, I am informed, completed, so far as the great majority of the bills are concerned, and I hope that it may be presented to the House within about a fortnight.

Tuesday, July 4.

The Blackrod Gas Bill (Lords) was reported, with amendments.

The petition of the Trustees of the Mostyn Estate against the Llandudno Improvement Bill (Lords) was withdrawn.

PUBLIC WORKS LOAN BILL.

On the order of the day for going into committee on this bill,

Mr. Sclater-Booth said the bill gave power to the Government to sanction loans to local authorities during the current year to the extent of £4,000,000, and he now proposed to make a short statement as to the indebtedness and current expenditure of the local authorities. From returns which had been made to the Government, it appeared that, in 1873, the local indebtedness of the country at that time amounted to £72,000,000. In the following year the figures were returned at £84,000,000; and the returns made up during the last few weeks showed that the total amount of indebtedness at the present time might be set down at £92,191,281. These figures required, however, considerable correction before it could be assumed that the differences between them represented the addition to local indebtedness between the three years referred to. In 1873 the outstanding loans which were returned amounted to £72,000,000; but subsequent information had shown that large sums of money were not included which ought to have been included. For instance, there was owing by Liverpool the sum of £2,200,000, which was not included in the returns; by Manchester, £2,300,000; by Blackburn, £300,000; and by other places various sums amounting in the total aggregate of £8,000,000 were omitted. Therefore, the corrected total for 1872-3 was £80,000,000, instead of £72,000,000. In 1873-4 the outstanding loans were returned at £84,000,000; but for reasons similar to those he had just indicated, there should be added to that amount £1,500,000, so that the corrected total for last year might be stated at £85,500,000. From that figure must be deducted £5,500,000 as the increased amount of indebtedness within that year. Information and returns received from other sources showed that there was received during that year, of borrowed money, £8,173,000. The chief items which made up this amount were as follows:—Town Councils and Urban Sanitary Authorities, £3,500,000; Metropolitan Board of Works, £1,500,000; and Harbour Authorities, £1,500,000; making a total of £6,500,000. The balance was probably made up by the sums borrowed under existing powers, which had not been made fully available. Up to the present time, the amount of indebtedness might be taken at £92,500,000. Deducting from that the corrected return of last year, £85,500,000, there appeared a difference of £7,000,000, but to that there must be added £4,000,000, which might be estimated as the amount of loans paid off during the year 1874-5. This would leave a difference of £11,000,000 between the indebtedness of last year and the indebtedness which was now returned. The amount raised on loan in 1874-5 was about £11,500,000. It was thus composed:—Town Councils and Urban Sanitary Authorities, £5,000,000; School Boards, £1,500,000; Metropolitan Board of Works, £2,500,000; and Harbours, £1,500,000; making a total of £10,500,000. It would thus be seen that the increase on the net indebtedness, after deducting repayments between 1872-3 and 1873-4, was £5,500,000, and a similar sum between 1873-4 and 1874-5, was £7,000,000. Of that sum, the Metropolitan Board of Works, Harbour Authorities, and School Boards raised 5½ millions. The Poor Law Authorities stood for 3½ millions, County Authorities for £3,144,000, Municipal Authorities for £5,900,000, Metropolis Local Management for £188,000, Metropolitan Board of Works for £11,144,000, Urban Sanitary Authorities for £33,274,000. The result was that this £92,000,000 was composed of £63,000,000 charged upon rates, and £28,000,000 charged upon tolls and dues. This sum of £92,000,000 which was due by England and Wales struck one as an enormous amount; but nearly half of the whole, or £45,500,000, was due by the Metropolitan Board of Works and the Urban Sanitary Authorities—viz., £12,000,000 by the former and £33,500,000 by the latter. This £45,500,000 represented substantial value—works which either of themselves were valuable property, or which added to the value of property—viz., sewers, street improvements, gas, and water. In point of fact, the money spent in that way was an economical mode on the part of the community of providing for the comforts, conveniences, and necessaries of life. These payments were in the nature of rents rather than of rates. They were in the nature of an additional rent paid by the occupier for what he would otherwise have to provide for his own comfort and convenience. On analyzing the £92,000,000 from another point of view, it would be found that £30,000,000 were charged on tolls and dues, and £60,000,000 upon a revenue derived from rates of about £20,000,000 per annum. Deducting the £45,000,000 due by the Metropolitan Board of Works and the Urban Sanitary Authorities, there remained only £15,000,000 for all others—viz., County Authorities, Borough Authorities, Poor Law Authorities, Highways, and School Boards. Again, adding to the sum of £45,000,000 due by the Metropolitan Board of Works and the Urban Authorities, the sum of £21,000,000 charged on the harbours and docks, there would be a total of £65,000,000, or two-thirds of the whole. The most important of the items was the £33,500,000 due by the Sanitary Authorities; and four great towns owed nearly half of this enormous sum—viz., Liverpool, £4,200,000; Manchester, £4,500,000; Bradford, £2,500,000; and Leeds, £3,200,000; or a total of £14,400,000. The total value of rateable property was estimated at £120,000,000, and, therefore, assuming an equally spreading charge over the whole country, the sum borrowed would amount to about half of the yearly rateable value. The question was whether the charge was increasing in proportion to the increase of the rateable value. He could hardly give a satisfactory answer to that question; but, taking 1867-8, the total rateable value stood at that time at £100,688,000; in 1869-70, at £104,405,000; in 1871-72, at £109,000,000; in 1873-4, at 115,606,000; and a return not yet presented would show that it was estimated for 1874-75 at £120,000,000. If a locality had to pay about half of its rateable value, that might be considered a moderate figure; under the Sanitary Acts it was so considered, and unless a larger sum was required there was no occasion to apply to Parliament. He was able to give only a rough estimate of the probable condition

of things a year or two hence; but, from the £92,000,000, £4.500,000 should be deducted for capital paid off, and that would leave £85,500,000 of local indebtedness. On the other side, the Local Government Board had sanctioned the borrowing of £1,500,000; Local Acts, £6,500,000, not all wanted within the year; School Boards, £1,500,000—total, £9,500,000, or £10,000,000. Therefore, the amount of local indebtedness twelve months hence would be about £95,000,000. The House would not fail to be struck by the large amount borrowed under private Acts of Parliament—viz., £6,500,000, and it might be interesting to know the relative proportion between the sums thus raised and the sums raised by the authority of the Local Government Board. In 1872, powers were given by local Acts for borrowing £2,831,000; by the authority of the Local Government Board, £602,000. In 1873 there was borrowed by the authority of local Acts. £1,389,500; by the authority of the Local Government Board, £980,000; in 1874, by the former, £1,094,000; by the latter, £1,457,000; in 1875, by the former, £6,505,000; by the latter, £1,975,000; the average amount borrowed during these four years being £4,208,000. The great bulk of these sums was not borrowed from the Public Works Loan Commissioners, but privately from the great corporations of the kingdom. It was under the Sanitary and Education Acts that the Public Works Loans Commissioners advanced at a cheap rate the greater part of the money to which the present Bill referred. So much for indebtedness—now for expenditure out of the rates. In 1874 the total amount actually raised by local taxation was £24,500,000: in 1875 it was £26,500,000, showing an increase of £2,000,000. The principal increase in the last, as compared with the previous year was, again, for the Metropolis £250,000; £250,000 for School Boards; and £2,000,000 for Urban Sanitary Authorities. That was balanced by a decrease in the poor-rate. There was also a decrease in the county and rural police rates, and in the metropolitan police rates. The principal items of increase were in the urban sanitary rates, the school board rates, and the metropolitan rates. There was a continuous and satisfactory reduction in the poor law expenditure, which had been going on for the last three years, and which showed a decrease of the £518,922 on the figure at which it stood in 1871-2. Next year would show an increase in four items—urban sanitary matters, poor rates, highway rates, and school board rates; but there would be a diminution in tolls. The diminution in poor-rate and generally in subventions would show more largely by £300,000. And here it was to be remarked that the subventions, though not on the urban sanitary rates, benefited the towns, as, for instance, the police subvention, which was as six to four for the towns. The general conclusion from what he had said was, that the non-remunerative rates showed a tendency to decrease, and the remunerative a tendency to increase. Next year there was no increase probable, except for sanitary improvement, education, and roads. It would be absurd to institute too close a comparison between the indebtedness of local rates and the indebtedness of the country generally. It would be observed, however, that whereas the public debt, which might be taken, in round numbers, at £750,000,000, was in the ratio of ten to one on the revenue of the country; taken at £75,000,000, the local debt charged upon £60,000,000 was in the ratio of only three to one; and the whole of the local debt was being paid off either by annual repayments, or by sinking-funds, the greater part of it being likely to be discharged in between 20 and 30 years, and the rest between 40 and 60. In the course of the inquiries it had been the duty of his department to make, they found occasionally that money was borrowed for the repayment of debts previously incurred; but there was a growing disposition on the part of localities to abandon that vicious system, and keep to stricter principles of finance. Besides, Parliament required in every private bill a clause to be introduced making it imperative that annual returns should be made to the Local Government Board, showing the amount to be invested in the sinking-fund; and if there appeared to be any failure in that respect the Local Government Board might get a *mandamus* to compel the payment of arrears. Then, in the Public Works Loans Act of last year there were some excellent provisions, which empowered the Public Loan Commissioners to take due security for the execution of the works for which the money was advanced, and the Local Government Board must satisfy themselves the money had been properly expended. As time went on, something, he thought, would be required to improve the practice of Private Bill Committees of both Houses, by making it more uniform over a long term of years, and to secure that notice of the total amount to be raised in each year should be given to Parliament. On the whole, the subject was one which called for attention and watchfulness, not for alarm or anxiety. According to the interesting return of his right honourable friend, the First Lord of the Admiralty, the average rate of the whole kingdom was in 1867 about 3s. 3¾d. At present the average rate throughout England and Wales was calculated to be 3s. 8¾d.; for the Metropolis, 4s. 1¼d.; and for England and Wales, less the Metropolis, 3s. 7¾d. His right honourable friend, taking a number of rural districts, made the average rate 2s. 9¼d. If we could arrive at a true estimate, he believed we should find that the average rate in the rural districts was from 2s. 6d. to 2s. 9d. Therefore, the pressure of the rates in the rural districts had not increased absolutely very heavily.

Mr. FAWCETT moved an amendment, declaring that an unduly large proportion of the charges involved in the payment of the interest and capital of the loans raised by local authorities falls on the occupiers, as distinguished from the owners of land, houses, and other rateable property, but,

After some discussion, the amendment was withdrawn, and the bill passed *pro formâ* through committee.

WEDNESDAY, JULY 5.

The Lords amendments to the Walsall Gas Purchase and Borough Extension Bill were agreed to.

The Llandudno Improvement Bill (Lords) was read a second time, and committed.

THURSDAY, JULY 6.

The Lords amendments to the Spennymoor and Tudhoe Gas, the Redcar and Coatham Gas, and the Southport Improvement Bills were agreed to.

The Blackrod Local Board and the Sutton Gas Bills (Lords) were read the third time and passed, with amendments.

Examiners report presented: "That the Standing Orders have not been complied with in the case of the Metropolis Gas (Surrey Side) Bill."

FRIDAY, JULY 7.

The Lords amendments to the Horncastle Gas and the Southampton Gaslight and Coke Bills were agreed to.

Legal Intelligence.

CLERKENWELL COUNTY COURT.—WEDNESDAY, JULY 5.

(*Before Mr.* GORDON WHITBREAD, *Judge.*)

WHAT IS A SUPPLY OF WATER FOR DOMESTIC PURPOSES?

THE NEW RIVER COMPANY *v.* JOB.

In this case the plaintiffs, the New River Company, claimed of *Alfred M. Job*, of 44 and 46, Cannon Street, City, wholesale stationer, three quarters water-rent, due to Lady-day last, for water supplied to Nos. 44 and 46, Cannon Street, as follows:—Three quarters rent at the rate of £12 per annum, being 3 per cent. on annual value of £400, £9; ditto for four closets, at the rate of £1 10s. per annum, £1 2s. 6d.; ditto for one high service, at the rate of 12s. per annum, 9s.; ditto for a urinal, at the rate of 6s. per annum, 4s. 6d., making the total claim of £10 16s.

Mr. GRAIN, who appeared to support the summons, said that the case turned entirely upon the 35th section of the Act 15 & 16 Vict., which was in the following terms:—"That the company shall, at the request of the owner or occupier of any house or part of a house in any street within their limits, in which any pips of the company shall be laid, or of any person who, under the provisions of this Act, or any Act incorporated therewith, shall be entitled to demand a supply of water for domestic purposes, furnish to such owner or occupier or other person a sufficient supply of water for domestic purposes, at the rates hereinafter specified—that is to say, for water supplied to any dwelling-house, where the annual value of the dwelling-house shall not exceed £200, at a rate per centum per annum on such value not exceeding £4; and where such annual value shall exceed £200, at a rate per centum per annum on such value not exceeding £8;" and then there followed certain additions which were entitled to be charged in respect of water-closets, fixed baths, &c. Mr. Job's premises had been valued by the company at £400 per annum, and upon that sum the defendant had been charged 3 per cent. The real bone of contention in the case was as to what came within the meaning of a "house," and of water supplied for "domestic purposes." He maintained that offices occupied during the day by a number of clerks and others engaged in business came within the meaning of a "house," and that the water which those persons drank, or with which they washed in those offices, came within the meaning of water furnished for "domestic purposes." The water might, of course, be used in other ways as well; but when it was not used for any of the purposes included in the 38th section of the Act, it clearly came within the category of being for "domestic purposes." That section ran:—"That a supply of water for domestic purposes shall not include a supply of water for steam-engines or railway purposes, or for warming or ventilating purposes, or for working a machine or apparatus, or for baths, horses, cattle, or for washing carriages, or for gardens, fountains, or ornamental purposes, or for flushing sewers or drains, or for any trade or manufacture or business requiring an extra supply of water." With reference to the valuation, no doubt a complaint would be made by the defendant; but the fact was that the valuation of the company was far below the assessment valuation. The defendant had been charged fairly, equitably, and properly by the plaintiffs; but if the company had proceeded upon their strict rights, they might have charged him double what they had done.

Mr. *Alexander Inglis*, clerk of the New River Company, produced the assessment sheet, showing the value put upon the houses of the defendant, Nos. 44 and 46, Cannon Street, City, for the water supply, which was at the rate of £400 per annum.

Cross-examined by Mr. RICKETTS: The assessment was from Midsummer to Christmas, for the half year then due; the revision took place on the 16th of December, 1875.

Mr. *Hibberdine*, collector to the plaintiffs, proved having made the demand for the water-rate upon the defendant for the three quarters up to March, 1876.

Cross-examined by Mr. RICKETTS: He only knew of one water-main in Cannon Street, but he was not the engineer, only a collector; he did not know, of his own knowledge, of any person sleeping on the premises.

Mr. *Charles Lee*, surveyor, said he had seen the premises. There were two shops—one occupied by Mitchell, steel pen maker, and the other by Schloss, importer of foreign goods. Part of the premises was occupied by the defendant, and the rest let out in offices to various persons, and he valued the property at £700 per annum. That was below the annual value by the last assessment of the Metropolis.

Mr. RICKETTS, on behalf of the defendant, submitted that the plaintiffs must be nonsuited on the ground that they had not proved the water was used for domestic purposes, nor was it shown that the clerks washed their hands, nor that any person slept on the premises. Had any one slept on the premises they would be liable to assessment for inhabited house duty, which was not so in this case, nor was there any proof that any persons washed their hands on the premises, and the onus of proof rested upon the plaintiffs. A portion of the water supplied to the defendant was used by him for purposes of business. Mr. Job had requested, under the 41st section of the statute, to be supplied with water by meter, but with this request the company refused to comply.

Mr. WHITBREAD said his judgment must be in favour of the plaintiffs, as he held that the water furnished by them to the defendant was for domestic purposes.

THE NEW RIVER COMPANY *v.* PEARSON.

The same question arose in this case, and at the request of the defendant a jury was empanelled to try the issue. The defendant, who is a stationer in Bishopsgate Street, was summoned for £6 16s., being the amount of four quarters water-rent on premises of the annual value of £150. £6; one closet, 8s.; and one high service, 8s; total, £6 16s. due at Christmas last.

Mr. GRAIN appeared in support of the summons, and stated that the company had valued Mr. Pearson's premises at £150 a year; that that valuation had been made in the fairest possible manner, and was a good deal short of the parochial value; and that if the company had chosen they could have charged the defendant more than they had done. The company had a right to charge according to the increased value of property; but they did not do so to the full extent which they might. They were perfectly entitled to re-value and re-assess, and to fix their rate at any sum they thought proper up to a certain amount.

Mr. *Inglis* proved the value of the property by the assessment of the company to be £150 per annum.

In cross-examination, he said the company put such a value on the property as they thought proper, upon the best information they could obtain from their officers. They took the poor-rate value only as collateral evidence. On being asked if some £50 shares of the company's had not been sold for five times the amount paid,

Mr. WHITBREAD said that had nothing to do with the case.

Defendant: Is it true that most of the water the company supply is obtained from the river Lea, for which they pay only £1500 a year?

Mr. WHITBREAD said they could not impeach the Act of Parliament. They could not interfere with the powers given by the Legislature, nor had they anything to do with the price at which the company bought or sold.

Mr. *Francis J. Wood*, collector of the water-rates, proved that he demanded four quarters water-rate of the defendant, which he refused to pay.

Cross-examined: No intimation was given to the defendant of the rate being increased, except that the amount demanded was stated on the note.

Re-examined: Any one had the right to appeal.

Mr. WHITBREAD said if there was any dispute as to the amount, it ought to have gone before a magistrate.

Mr. *Charles Lee*, surveyor, valued the premises at £230 per annum; it was a large old-fashioned house, with two shop fronts, part being occupied by the defendant in his business, and part let out as offices.

Cross-examined: He took the value as it was. If there had been no shop nor offices let out, the value would have been less.

The *defendant*, who conducted his own case, denied his alleged indebtedness to the company, and maintained that the sum sued for was more than was allowed by the Act; that an annual payment of £5 12s. having been previously agreed upon between him and the plaintiffs, no higher sum could be demanded without proper notice; that his premises did not constitute a dwelling-house, and that the water supplied to them was not for "domestic purposes," and that no

increase of former charges could be made for the first six months, as he had no notice of a rise until June, 1875, and had not the option of refusing to take water at an increased charge.

Mr. WHITBREAD said that in this case also his opinion was the water was supplied to a "house" occupied by the defendant for "domestic purposes;" and if that were the law, as he held it to be, it was the duty of the jury to give a verdict for the plaintiffs.

The jury appearing to have some doubt amongst themselves on the subject,

Mr. WHITBREAD remarked that he had, according to his limited comprehension, told them the law; and if they did not think right to follow what he had so said, they could be discharged.

After some further consultation, one of the JURYMEN announced, on behalf of his brethren, that they had agreed to a verdict as indicated by the judge. At the same time they had considerable sympathy with the defendant in the matter.

Mr. WHITBREAD said the jury had, of course, a right to express their sympathy, but they could not struggle against an Act of Parliament.

WANDSWORTH POLICE COURT.—WEDNESDAY, JULY 5.

(*Before Mr.* BRIDGE.)

LIABILITY OF INCOMING TENANT FOR ARREARS OF GAS-RENT.

The Wandsworth and Putney Gaslight Company were summoned by Mr. Robert Scarlett, an accountant, for neglecting to give a supply of gas to 36, North Street, Wandsworth.

Mr. STURT, in support of the summons, said the complainant was the occupier of the premises, the lease having been assigned to him by the trustee of Mr. Lloyd, the tenant, who filed a petition of liquidation under the Bankruptcy Act. The complainant was a creditor, but he gave up his claim on the assignment of the lease to him. He was carrying on the business, and he applied to the company to lay on gas to the premises. A reply was received stating that Mr. Lloyd was in debt to the company, and that the service had been disconnected until £7 1s. 11d. had been paid.

Mr. STORRY, on behalf of the company, contended that Mr. Lloyd was virtually the occupier. If there should be another tenant, the company would not object to lay on the gas. Under the special Act, the company had the option of refusing the supply.

The *complainant* confirmed Mr. Sturt's statement. He said Mr. Lloyd, who was a draper, had no interest in the premises. Witness was not a draper. He paid Mr. Lloyd £2 a week as his manager. If he could repay him, he should be content to recover his money.

Mr. BRIDGE refused to make an order, as he came to the conclusion that the old tenancy existed.

Miscellaneous News.

METROPOLIS GAS SUPPLY.

METROPOLITAN BOARD OF WORKS.

METROPOLIS GAS (SURREY SIDE) BILL.

At the Meeting of the Board on Friday last, the Parliamentary Committee presented the following report:—

Your committee have to report that a bill has been submitted to the House of Commons by the President of the Board of Trade, to give effect to the proposed arrangement with the London, Phœnix, and Surrey Consumers Gas Companies, upon which your committee reported to the Board on the 19th of May last.

The bill, as introduced into Parliament, differs slightly from the draft bill as amended by your committee on behalf of the Board. First, with regard to the acquisition of land by agreement with the consent of the Board of Trade, it was proposed in the draft bill, as amended by your committee, that such power should be subject to the condition contained in the 5th section of the Gas-Works Clauses Act, which prohibited the storeage of gas except upon lands described in the companies special Acts, without the previous consent in writing of the owner, lessee, and occupier of every dwelling-house situate within 300 yards of the limits of the site where such gas is intended to be stored. The Board of Trade has omitted this proviso from the bill, for the alleged reason that it would be of no advantage to the company to have power to buy land unless it was able to use it for the purpose of manufacturing and storing its gas. It appears to your committee, however, that the proviso in question is one which should be retained, and they have directed the Board of Trade to be informed to that effect.

Secondly, as regards the power of amalgamation, in the draft bill, as originally submitted to the Board of Trade, it was provided that only the three companies named in the bill should be allowed to amalgamate among themselves, and this was in accordance with the provisional arrangement made with the companies and the Board of Trade. In the bill before the House of Commons, it is provided that the three companies may not only amalgamate among themselves, but with other companies supplying gas on the south side of the Thames, which would include the South Metropolitan Company. The Board have already expressed the opinion that the power of amalgamation should not extend to the last-mentioned company, and your committee have requested the Board of Trade to alter the clause relating to amalgamation accordingly.

The third point to which your committee have to direct attention is the clause empowering the London and Surrey Consumers Companies, during two years after the passing of the Act, to make up their reserved funds to the amounts to which they might respectively raise the same under their present Acts, provided that nothing shall be carried to their reserved funds in any year in which the companies shall charge more than the standard price for gas, or declare a dividend exceeding the standard rate. Your committee, when they reported to the Board upon this subject, on the 19th and 26th of May last, were of opinion that the power of forming a reserved fund in the way proposed should not be given to the London and Surrey Consumers Gas Companies. Upon further consideration, however, it appears to them that, looking to the desirability of some arrangement being come to, the Board should consent to this provision, and they recommend accordingly.

Mr. FREEMAN moved the adoption of the report, which was seconded by Mr. LE BRETON, and carried.

METROPOLIS WATER SUPPLY.

QUALITY OF THE NEW RIVER WATER.

In the *Daily News* of the 27th ult appeared the following paragraph:—

"INNS OF COURT PUMPS.—Mr. W. Foster, F.C.S., Lecturer on Chemistry at Middlesex Hospital, writes to us:—'A short time ago a neighbouring medical man residing in one of the inns requested me to examine the water from the pump in New Inn, and as the analysis has shown that it is very impure, it is thought that a report of the analysis may be interesting to some of your readers. This water, I may state, has the reputation of being very pure and sparkling, and is not only used by some of the residents of the inn, but also by a large number of persons living in the neighbourhood. At certain times of the day, when the pump is not locked, there is a continual stream of people passing to it with their jugs, water-bottles, and the like. For the purpose of comparison, analyses were made of the water from the pump in Lincoln's Inn and of that supplied by the New River Company, and the results of the three are appended. The quantities are expressed in grains per gallon. New Inn, total solids dried at a temperature of 212° Fahr., 92·4; chlorine, 7·40; ammonia present as ammoniacal salts, ·210; ammonia obtained from animal and vegetable life, ·012; nitrogen present as nitrates, ·753—Lincoln's Inn, total solids dried at a temperature of 212° Fahr., 18·9; chlorine, ·98; ammonia present as ammoniacal salts, ·005; ammonia obtained from animal and vegetable life, ·006; nitrogen present as nitrates, ·200—New River, total solids dried at a temperature of 212° Fahr., 19·7; chlorine, ·98; ammonia present as ammoniacal salts, ·004; ammonia obtained from animal and vegetable life, ·007; nitrogen present as nitrates, ·172. A glance at the above results shows that the water from the pump in Lincoln's Inn is of as good a quality as the New River Company's water, which is considered one of the best supplied by the London companies. The water from New Inn contains about five times more solid matter than either of the others, and this is largely composed of ammoniacal salts. Chlorides and nitrates are also present in large amount. Now, ammoniacal salts, chlorides, and nitrates are always present in sewage, and are its characteristic chemical constituents. There can be little doubt that the undue amount of these three substances in the New Inn water is due to drainage from the surrounding parts. When we consider the densely-populated state of the neighbourhood, it is difficult to conceive how drainage materials could possibly be absent. Why the water from the pump in Lincoln's Inn is so exceptionally pure I have yet to learn. Popular belief is often most misleading, and with reference to the New Inn water is extremely dangerous. The inhabitants of the district have an unlimited supply of pure water within their reach, so that no hardship would arise were the pump entirely closed. It is clear that this is the proper course to pursue.'"

In reference to the above, we have been requested by Dr. Bischof to publish the annexed letters:—

To the Editor of the JOURNAL OF GAS LIGHTING, *&c.*

Sir,—The editor of the *Daily News*, to whom I addressed the enclosed letter, has, for reasons best known to himself, up to this day, not taken any notice of my correction of an obvious misstatement published in his issue of the 27th ult. May I ask you to insert the letter in your JOURNAL? I remain, sir, your obedient servant, GUSTAV BISCHOF.

Analytical Laboratory, 4, Hart Street, Bloomsbury, W.C., July 1, 1876.

[*Enclosure.*]

"INNS OF COURT PUMPS."

To the Editor of the "Daily News."

Sir,—In your issue of to-day I find a statement by Mr. W. Foster, that New River water contained, "a short time ago," ·004 grains of free ammonia per gallon, or to express this in more convenient language, ·0057 part per 100,000. I have recently made a number of analyses of New River water, and found it remarkably free from ammonia, containing even less then ·001 part per 100,000. Referring also to the Registrar-General's reports of the present year, as far as I have them before me, I find that New River water was free from ammonia in January, February, and April, containing only in March ·001 part per 100,000. I have no doubt the figures in your article are due to an error in printing, but as they would convey to any one at all acquainted with London water the notion of a most alarming deterioration of the New River water, you will, I hope, excuse my troubling you with these lines.

Mr. Foster's statement, that nitrates are amongst the characteristic constituents of sewage, is evidently a slip of the pen, the reverse being the case.

I remain, sir, your obedient servant, GUSTAV BISCHOF, F.C.S.

Analytical Laboratory, 4, Hart Street, Bloomsbury, W.C., June 27, 1876.

PURCHASE OF THE WAKEFIELD WATER-WORKS COMPANY BY THE CORPORATION.

On Friday, the 30th ult., a Special Meeting of the Wakefield Town Council was held—the MAYOR (Alderman Gill) in the chair—to consider certain negotiations which had been entered into for the purchase of the rights, powers, and privileges, and works and plant of the Wakefield Water-Works Company, and to approve or disapprove of the same, as the council might think fit; and to pass all such resolutions relative thereto as might be deemed advisable.

The TOWN-CLERK read the two following minutes.—"At a meeting of the Sub-Parliamentary Committee of the council, on the 27th day of June, it was resolved to recommend to the council, at the special meeting convened for Friday, the 30th inst., to purchase (subject to the sanction of the Local Government Board being obtained) all the rights, powers, and privileges, and all the premises and other property of the Wakefield Water-Works Company, at the following prices—namely, £48 for each original £25 share; £24 for each original £12 10s. share; £11 for each original £10 share, paid up; such purchase to be subject to all the existing liabilities of the company."—"That, in case the council, at the meeting to be held on Friday next, disapprove of purchasing of the rights, powers, and property of the Wakefield Water-Works Company on the terms of the previous resolution, the town clerk and solicitor take all such proceedings as they may think advisable in opposing the bill of the water-works company now before the House of Lords, on the ground that the proposed source of supply would be bad in quality, and that the company can obtain a sufficient supply of water equal in quality to the Wath water near the present works of the company; and that the town-clerk and solicitor also endeavour to obtain the insertion in the bill of the clauses now submitted."

After some explanations by the MAYOR, the TOWN-CLERK said, in accordance with the recommendation of the Sub-Parliamentary Committee, he had prepared the following resolution:—"That it be and it is hereby resolved that the council, as the Urban Sanitary Authority, purchase (subject to the sanction of the Local Government Board) all the rights, powers, and privileges, and all the premises and other property of the Wakefield Water-Works Company, on the following terms—viz., the corporation to pay £48 for each paid-up original £25 share; £24 for each paid-up original £12 10s. share; and £11 for each paid-up £10 share; and, in addition, the corporation to take over the debts and liabilities of the company existing at the time of purchase."

Mr. DIXON: Has the town-clerk ascertained what the liabilities of the company are?

The TOWN-CLERK: The solicitor has ascertained, I believe, as near as possible, what those liabilities are. The bank debts are about £7000.

Mr. MACGIBR: That is on current account?

The TOWN-CLERK: That is so. Then their expenses connected with the Holmfirth scheme are put down as £4000, still owing. The cost of their present application is stated to be £10,000; their mortgages, £7500; and their new filters, £1500.

The MAYOR: Does that £7000 owing to the bank include a sum of £5130 uncalled-up capital?

Mr. H. LEE: That covers the unappropriated capital.

A long discussion ensued upon the propriety of the purchase, and

Mr. T. HAIGH proposed a resolution confirming the proceedings of the committee, and proposing that the council, as the urban authority, should purchase (subject to the sanction of the Local Government Board) all the rights, powers, privileges, premises, and other property of the water-works company on the terms mentioned in the report. This was agreed to on a division by a majority of twelve to eight. Two members were neutral and ten were absent.

SALE OF GAS SHARES AT WHITEHAVEN.—On Thursday, the 29th ult., Mr. James Jackson, auctioneer, offered for public sale a number of £20 shares and £5 shares, both fully paid up, in the old gas company. The £20 shares were sold for £50 each, and the £5 shares for £12 10s. each.

HALIFAX CORPORATION GAS-WORKS.—At the monthly meeting of the Halifax Town Council, on the 5th inst., the Gas-Works Committee brought up a report recommending that the salary of Mr. Carr, the manager, be increased from £250 to £300 per annum, from the 1st inst., and that at the expiration of two years from that date it be advanced to £400 per annum, provided his services continue to be satisfactory to the council. After a long discussion, in which the "vestry mind" of the corporation exhibited itself strongly, and grave apprehensions were expressed about the results of too great liberality in their arrangements, the latter part of the committee's report was negatived.

BRITISH ASSOCIATION OF GAS MANAGERS.

(*Continued from page* 17.)

TUESDAY, JUNE 13.

The SECRETARY read the following paper, by Mr. W. RICHARDS, of London, on

THE THEORY OF RETORT-SETTINGS.

The importance of the subject I have chosen is, for the manufacturer of gas, hardly susceptible of exaggeration, since, on the proper setting of retorts, alike depend the profitable production and the quality of gas, the economy of fuel, cost of wear and tear of the apparatus used in carbonizing, the saving of labour, and various other advantages which contribute to the prosperity of a gas company.

Although I am aware that the question has engaged the attention of some of our most intelligent members on former occasions, nevertheless I am of opinion that it has not been exhausted, and as my intention is to enter principally into the theory of the subject, in most respects my communication will differ from those of my predecessors. Necessarily, there will be much introduced to your notice with which you are acquainted, and, perhaps, assertions made contrary to the generally accepted opinions, but as my only desire is to contribute towards our general stock of knowledge, for any deficiencies or errors I must crave your indulgence.

Connected with my subject there are four distinct points for consideration: 1. The most advantageous method of obtaining the caloric requisite for carbonization. 2. The best means of conducting this to the retorts, and consequently to the coal undergoing distillation. 3. How to prevent the heat passing off uselessly from the ovens to the atmosphere; and, lastly, how to avoid unnecessary loss of caloric by radiation, either from the foundations or the exterior of the benches.

With regard to the first consideration, that is, the most advantageous method of obtaining the caloric, the principal requisite is a proper draught or current. For this object the passage into the furnace at the ash-pans should be clear, the flues of ample dimensions, and the stack of suitable height and internal area. The next consideration is the kind of fuel employed, whether this be coal (which, however, is rarely used for the purpose) or coke from cannel coal, or that obtained from caking coal.

When employing coal as fuel, the area of the furnace will be required of sufficient capacity for the admission of a proper supply of atmospheric air, to intermix with the volatile constituents of the fuel; by this means flame is produced, and the smoke which would otherwise exist is avoided, so preventing the loss of heat and other inconveniences. When coke from cannel coal is used for the purpose in question, then, in consequence of the amount of ash intermixed therewith, and consequently a less vivid combustion, a comparatively large quantity is required, demanding a furnace of large dimensions, so that the intensity of heat acquired by the coke from caking coal is compensated by the quantity in a less intense degree derived from cannel coke. On account of the uncertain proportion of volatile matter existing in the various coals used in the furnaces, and the indefinite proportion of ash in cannel coke, I am led to believe that no definite rule can be applied in the construction of furnaces for these materials.

This, however, is very different with coke derived from caking coal, which generally contains considerably less ash than that from cannel, consequently possesses a greater quantity of carbon, and is more uniform in its composition. Moreover, this carbon being fixed, the supply of atmospheric air is required of greater regularity, and in less quantity, than when consuming coal. Therefore, for this kind of fuel a furnace of small area and great depth becomes necessary. The principal advantage of the deep furnace being that the air in its passage is heated to an intense degree, which is subsequently disseminated throughout the oven. The steam from the ash-pans is likewise decomposed when passing through the incandescent fuel, and becomes also a source of heat.

The coke from caking coal being uniform in quality, as stated, admits of a general rule being applied for the construction of furnaces of settings heated by it, and in the absence of a better (for, so far as I am aware, nothing of the kind has yet been made public), I would suggest that the area of the furnace at the level of the fire-bars should be equal to one square foot per ton of coal carbonized per diem; from this would have to be deducted the space occupied by the fire-bars. These are usually made of 2 inch square wrought-iron bar, being much more durable than cast iron, supported on wrought-iron bearing bars; one fire-bar being sufficient for each square foot of furnace.

Following this rule, for a bench of three small retorts, carbonizing a ton of coal per day, the furnace would be required 2 feet 4 inches long and 5 inches wide. For a bed of five or six retorts, carbonizing two tons, it would be 36 inches long and 8 inches wide, having two fire-bars; and for a third of eight retorts, distilling three tons, the length of the furnace will be 3 feet 6 inches, and 10 inches in width, provided with three bars.

The depth of the furnace in all cases being equal to twice its width, splaying at the sides, so that at the top it shall be one-third wider than at the bottom; I may add that I find these measurements correspond with the constructions of some of our first engineers, and, therefore, submit that they be considered correct, and thus put an end to a question which seems to have occasioned some trouble to Dr. Schilling, on account of the varied dimensions employed by different engineers, as described in his excellent work on Gas Lighting.

The next point for consideration—the best method of conducting the heat—is somewhat comprehensive, and embraces points on which engineers differ; therefore, it will not be surprising if some of my statements are disputed by many. I must first observe that the caloric, as generated, is conducted in direct lines, radiating from the point of production, and necessarily in order to obtain the full advantages of this, no obstructions nor impediments to its free conduction should exist between the furnace and the retorts to be heated, except so far as may be absolutely essential to protect them from the most vivid action of the caloric. Further, for the sake of economy, the furnace should be placed as near as possible to the retorts. These remarks apply only to the heat conducted directly; there is, however, for consideration, that conveyed by the draught or current passing through the oven, which may be termed indirect conduction.

In all well-constructed settings, the current of heated air is retained in contact with the retorts for a time, in order that its heat may be absorbed in its transit, and thus, as small a portion as possible of the caloric shall be permitted to pass uselessly to the atmosphere. This, as is well known to gas engineers, is accomplished by giving a circuitous direction to the current by means of flues, but I am disposed to believe that frequently the application of these flues is strained beyond the points of utility or economy. In the plan of a bench of retorts which recently came under my notice, there were three flues under each of the lowest retorts, and those which led into the vertical flue ran parallel, and in close contact with the sides of the furnace. Here, undoubtedly, the very opposite of the effect desired was produced, as the current in this case would obtain a certain quantity of heat, through wall of furnace, which it would carry away. I venture to assert my conviction that the importance of circuitous flues is much exaggerated, that they are frequently misapplied, and that after the current is conveyed to the end of the oven, brought forward and conveyed under the retorts to the vertical flue by any additional flues beyond this, no practical advantage is to be gained.

For the purpose of explaining my views on the subject in question, and pointing out advantages and what I consider to be defects in retort setting, there are three diagrams of different systems.

Fig. 1 represents the cross section of a bench of retorts as often employed in works of medium capacity, and possesses that great desideratum, simplicity. In this you will observe that the caloric as generated, is conducted directly to the retorts as represented by the radiating dotted lines, there being no arch nor other obstruction besides the two shields to protect the lower retorts, with

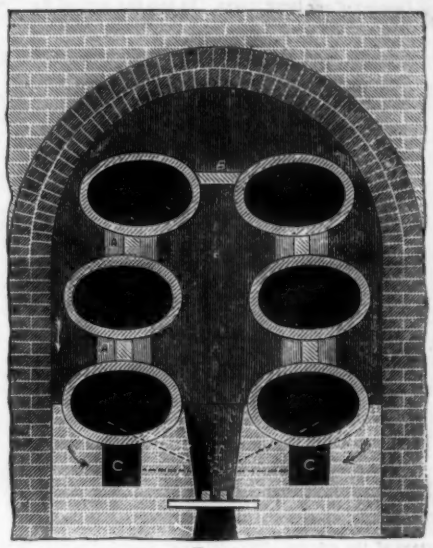


FIG. 1.

which the furnace is in immediate contact. The supporting blocks, A A, extend the whole length of the bench, and prevent the current passing at those points. The slab, B, between the upper retorts extends from the front wall to within a foot of the back, leaving an orifice of that length at that point. The current of heat ascends as marked by the arrows, passing to the back through the orifice mentioned, and descends along the outer sides of the retorts to the flues, C, passing under the bottom retorts to the vertical flue, and hence to the main flue, a damper separating the former from the latter.

Many present who are accustomed to embed their retorts in transverse walls, or support them by bricks, will be surprised at the absence of these, to which reference will be made hereafter, and will form a prominent feature of the present communication. I am sorry that I am not in possession of the name of the author of the setting represented, which is of extreme simplicity and efficiency, two most important points, and can be highly recommended to all who desire economy in fuel for carbonizing, as I have been informed from several sources, which opinions my own experience confirms.

For the further purpose of illustration I beg your attention to fig. 2, which will be recognized as a section of a bench of iron retorts as constructed

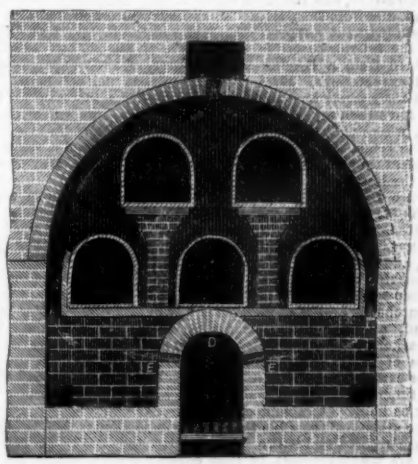


FIG. 2.

before those of clay were adopted. The arch, D, over the furnace, extends throughout the length of the bench, and is provided with nostrils, E E, at both sides, for the passage of the current of heat, as indicated by the arrows. And here let me request your attention to the marked difference which exists between the two settings.

In fig. 1, as described, the heat as generated is conducted directly to the retorts, the current being but a secondary consideration. But in the setting in question all the obstacles of arch, slabs, and guard-shields oppose the direct conduction, and consequently the current is an important consideration. Therefore, with all this quantity of non-conducting material, it can hardly be surprising that the retorts were frequently at too low a temperature for carbonizing, whilst the interior of the furnace beneath was at a white heat. This was a frequent occurrence with this kind of bench, arising from the construction, sometimes through the nostrils being too small, or the side passages, G G, being too contracted, either as first built, or by being obstructed with the carburet of iron dislodged from the retorts. Therefore, in fig. 1, the caloric is conducted directly, the current of heat being a secondary point; whilst in fig. 2 the greatest impediments are presented to direct conduction, and the current is the main source of heat. I have the impression that with our present knowledge, if we were compelled to resort to the use of iron retorts, another and more rational method of heating them would be adopted, and instead of having the fuel and furnace at a white heat, whilst the temperature of the retorts was not more than 1500° or 1600°, that by extending the surface of the furnace, modulating the degree of heat, avoiding all the obstructions to the conduction of the heat, so assimilating the temperature within the oven to

that in the furnace, under these conditions the retorts would be heated more uniformly, and never be burnt out. A similar system to this is adopted by Mr. Spice in the manufacture of hydrogen gas, with the greatest success; therefore, if applicable in one case, there is no reason why it should not be successful in the other.

Fig. 3 represents the section of a bench of retorts as employed, with some modification, in most of our large works. In this the arch of fig 2 is retained, and, like the other, extending the length of the bench, and having the nostrils

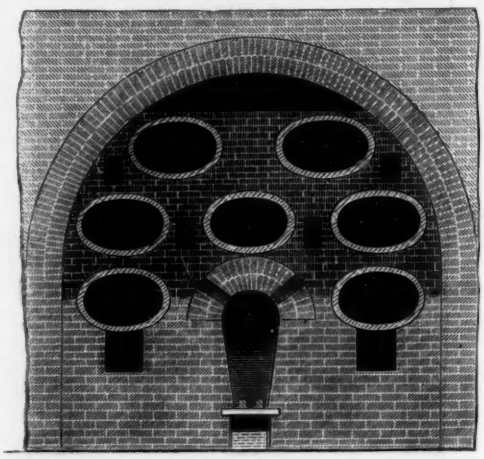


FIG. 3.

for the passage of the caloric. The slabs and guard-tiles are dispensed with, but transverse walls are added, thus offering a large mass of non-conducting material, which, with every confidence, I assert must increase the quantity of fuel for carbonizing to a serious extent.

The arch, as applied in old settings, was to protect the retorts from the action of the intense heat, which would rapidly destroy the iron, but why it is retained with clay settings I cannot understand. That supports for the central retorts are required, we know; but for the purpose, if they were made 9 inches or a foot long, and placed at intervals of 2 feet apart, these would be sufficient. This done, the communication between the furnace and the interior of the oven would be of such ample capacity as practically to occasion no variation between the temperature beneath, and above the arch.

I am equally at a loss to understand the reason for retaining the transverse walls in modern settings, which I believe were originally placed to support the clay retorts—in short, to prevent them dropping to pieces; this, however, was done at a period when their manufacture was but little understood, and such means were desirable, but at the present time clay retorts can be manufactured which require no such support or protection.

The writer's first experience of clay retorts was acquired abroad about 24 years ago, before they were introduced into general use in the metropolitan works, and in his ignorance he set them like those of iron, except by dispensing with the guard-tiles, and the slabs beneath, and in butting the retorts against the end wall, and from that time he has never deviated from the principle of leaving them without support. At first some difficulty was experienced on account of the inferior description of retorts employed, but eventually others were obtained from a Belgian manufacturer, of such excellent quality as to surpass all expectations. With these there was neither crack nor fissure throughout their whole length, and after having been in action for two or three years they have been taken down, and invariably in one entire piece from the bolt-heads, where they were usually broken; but in some few instances the whole of the retort was intact, and they have been re-set a second time, with the only defect that by the action of the scoop and rake they were somewhat thinner in the lower part.

I am aware that my assertions must be received by some present with a degree of doubt, but I assure you that there is neither exaggeration nor the slightest attempt at colouring in my statement. However, I must inform you that the retorts of only one firm that I ever met with approached this degree of excellence, and for obvious reasons I withhold the name.

Retorts of this quality being produced, the question arises, "How is it that they are often so different?" This, I think, rests with companies, who generally desire to purchase cheaply at per foot run, whereas those I refer to are sold by weight, and, although much dearer in their first cost than those in the English market, yet, by the extraordinary advantages arising from their use, the absence of the transverse walls, the diminished leakage, the reduced fuel required for carbonizing, these, in the lifetime of a retort, repay the extra cost a hundred times over, and no engineer who has experienced their advantages, would ever be induced to abandon them.

It may be asked, is it possible that only one particular firm is capable of producing these retorts, and is it only limited to Belgium? To this I will state, that there are manufacturers in that country whose retorts are not equal to those made in England and Scotland; and I firmly believe that, if paid for and if demanded, all our first manufacturers could and would produce retorts of the excellence referred to, and I could mention an English firm that approaches very closely thereto, and I believe only by the proper admixture of materials that such a degree of excellence is principally attained.

The manufacture of clay retorts of the first quality is an operation of great care. For the purpose, granulated burnt fire-clay is intermixed with a portion of fire-clay in a plastic state, and I have been informed that the smaller the proportion of the latter, the more suitable is the retort to withstand the action of the heat, and to remain intact. On the other hand, as thus made, retorts are exceedingly fragile, requiring to be packed between battens in order to prevent their breaking during their transport, and are so soft that often the pieces of burnt clay can be detached by the finger-nail. Their expense is further increased by cost of package. From trials made with good retorts when cold, I have found them to retain gas at ordinary pressure; therefore, in the ordinary acceptation of the term, they are not porous but cellular, each cell being distinct, as represented in the longitudinal section of a honey-comb, and the mass of these prevent porosity.

On a visit I once made to the factory where the retorts referred to were made, I was struck by the absence of machinery, the paste or dough forming the retort being kneaded by men treading upon it, and the small lumps, each rather larger than a man's fist, of which the retort was built, were all kneaded by hand; and, on inquiry, I was informed that only by these means could excellence be obtained—that machinery had been tried and abandoned on account of the inferior quality of the retorts produced thereby. The statement would appear somewhat incredible, but there were the men at their laborious work, and I was shown the machinery lying idle, therefore no doubt could exist, and I shall be glad to know, at some future period, that these hints have been serviceable.

The "behaviour" of the retorts, however, does not consist only on their excellent quality, but also in the method of setting them, particularly in the absence of transverse walls or other means of crushing them by any movement of the arch forming the oven, and I have no hesitation in saying that any clay retorts when imbedded in brickwork must be broken whenever there is the slightest settlement; thus the means taken to preserve them is often the cause of their breakage.

Having made the broad statement that the presence of the arch extending throughout the oven and the transverse walls are conducive to excessive fuel, I may observe that I am aware that the generally accepted opinion is, that when brickwork is once heated to a certain degree, it offers no obstruction to the free passage of the caloric, which opinion I dispute.

That this is erroneous is made evident by the arch, slabs, and guard-tiles; as seen in fig. 2, these were all placed to obstruct the heat and preserve the retorts, which purposes were effectually accomplished. Therefore, if this were the case with the iron retorts, it must be equally true with those of clay; the arch being a non-conductor in the one case, it must be equally so in the other. Again, the effect of this non-conducting medium in all benches having the arch, is rendered palpable by the difference of the temperature within the oven and that in the furnace, whereas in settings as represented by fig. 1, there is practically no difference between the top of the furnace and the rest of the oven. Therefore, the arch does obstruct the passage of the heat.

Again, if we reflect on the great increase of fuel required to produce a given quantity of steam by any incrustation within a steam-boiler, or the necessity of placing thin tubes in surface condensers, then we realize the prejudicial effects of the intervention of any superfluous non-conducting material, as well as providing the simplest obstructions for the passage of the caloric—all-important points to be imitated in retort-settings.

But it may be asked, what becomes of the heat if it is not transmitted by the brickwork? To this I may ask, what becomes of the light from a lighted candle when placed "under a bushel?" There are, moreover, laws connected with caloric with which we are unacquainted; but, as I have endeavoured to show, whenever an obstruction to its free passage exists, it is proportionately ineffective, but when conducted with freedom to the desired point, then only is it applied economically. I may, however, state that heat, when obstructed, passes to the general block of brickwork, and even to the ground.

The question may arise, how is it that these arches and transverse walls are retained if they are not requisite? To this may be replied, that we are very imitative and conservative. The arch is retained from the old settings; the walls, because our engineers will not dispense with them. For 50 years the lamplighters used to ascend and descend ladders every night and morning, in order to light and extinguish the public lamps, the lighting-rod, employed in France from the first establishment of gas in that country, being utterly disregarded. Therefore, if the ridiculous system existed of causing hundreds of men to run up and down ladders nightly to no purpose, it cannot be a matter of surprise if the arches are retained.

We now come to the next question—namely, the means of preventing the caloric passing uselessly from the ovens to the atmosphere—concerning which little will require to be said, although such is its importance that, within the writer's knowledge, the success of a continental gas company was materially prejudiced during several years by inattention to the subject in question.

For preventing loss from this cause, dampers are placed on the flues at the entrance to the main flue. This, indeed, is the point of separation between the oven and atmosphere; hence the smaller the orifice left open by the damper, so will the waste heat be proportionately diminished. If the damper is left open beyond the necessary degree, a portion of the fuel passes off in a gaseous state uselessly to the atmosphere; and with large orifices and strong draught, an incredible loss of fuel is the result, in consequence of the heat, as generated, passing with such rapidity as not to give time for its absorption—similar, in effect, to passing the hand quickly through a gas or other flame.

An instance of the waste of fuel occurred at the continental works alluded to, where brick retorts alone were used, and, singular enough, dampers had never been adopted. This state of affairs had existed for years, the consumption of coke for fuel being upwards of 75 per cent. of the production. When, however, dampers were placed and adjusted, a saving of about half the fuel for carbonizing was effected. In this case, although the works at the period were small, no less than four tons of coke escaped uselessly daily in a gaseous state from the chimney, without a trace of the loss, except in the balance-sheet of the company and the dividends of the shareholders. Therefore, to all interested in the economical production of gas, the damper, properly adjusted, is of paramount importance.

The damper, as is well known, is a fire-clay tile, working on a flat slab, having the orifice cut therein, both of which should be nicely fitted at the opening communicating with the main flue; under ordinary circumstances, there is not more than one square inch for each mouthpiece; hence, for six single retorts, an opening of six square inches will be sufficient. In adjusting a damper, it should be first closed to that point where the flame issues from the sight-holes when, on gradually opening, until the flame ceases to issue, then the proper degree of orifice will be obtained.

The last consideration—the radiation of heat from the exterior and foundations of the benches, as well as the influence of the temperature of the surrounding atmosphere of the retort-house, as affecting economical carbonizing—also merits attention. Familiar illustrations of the means of preventing the radiation of heat exist in the domestic article called the "cosey," which is met with on most English breakfast-tables, as also the apparatus called the Norwegian Kitchen. For the purpose of this paper, I made an experiment with the former, by which I ascertained that, when a teapot was filled with boiling water, the temperature of the atmosphere being 50°, in the course of 32 minutes the temperature of the water was reduced to 60°; but by repeating the experiment, and covering the vessel with the cosey, only at the end of three hours and a half was the water reduced to the temperature stated.

Again, with the Norwegian Kitchen, which is simply a wooden box with a lid lined throughout with felt, and containing a tin can. With this a stew is parboiled, placed in the apparatus, and at the expiration of three or four hours the food is cooked and hot, whereas, if it were exposed to the temperature of the atmosphere, the heat would only be retained a few minutes.

Here are two remarkable instances showing the necessity of applying all available resources to prevent loss of heat, and consequently loss of fuel, by undue radiation from the benches, which can only be accomplished by making the foundations, the tops of benches, all the walls, and even the main flue, of ample thickness. No front wall of a setting should be less than 14 inches, and if increased to 18 inches the retorts will be heated to the mouthpiece. When the top of a bench is 2 feet 6 inches thick at the crown of arch, a person can conveniently walk on it when the retorts are in action, but if only half that thickness, wood will be speedily charred when placed thereon. From this may be judged the necessity for the thick wall, in order to prevent loss of heat by radiation.

A retort-house once came under my notice where the arches of the settings were merely covered with sand, and this was so hot that a piece of wood placed thereon was immediately charred. The front walls of the benches were only 4½ inches thick; by this means the manager conceived that the retort would be better heated towards the mouthpiece, whereas the reverse was the case, on account of the excessive radiation. I need hardly say that the retort-house was

of the hottest, and the fuel consumed excessive, which must always occur when excessive radiation is permitted, and by such means the loss is just as positive as in allowing the coke to pass up the chimney, or its money value to be thrown in the depths of the ocean.

I have now to request your attention to the influence of the temperature of the atmosphere on heating retorts. This, I think, is a question which has received but little reflection, although some years ago, when ventilating shafts were first introduced into a metropolitan retort-house, their effects on the heat, as well as the increased fuel requisite for carbonizing, were fully recognized.

Since that period, however, our engineers, with a very laudable consideration for the comfort of the stokers, as well as providing storeage for the coal within the building, have increased the magnitude of their retort-houses to such an extent, that beyond a few feet from the benches the temperature is about the same as the external atmosphere, and it follows, under such conditions, that external radiation must be increased. It becomes, therefore, questions of the comfort to the workmen, and the economy in transporting the coal, against the increased loss by radiation.

The experience acquired, however, at Beckton, where their first retort-houses are 90 feet in width, and the more recently constructed have been increased to 100 feet, would lead to the conclusion, that the loss on this account cannot be material, but circumstances which occurred to myself impress me with an opposite opinion.

Some years ago, being engaged in the construction of a new work abroad, having everything ready, except the roof, of which the principals and laths were placed, the sheets for covering not having arrived, the directors of the company being anxious to commence operations, and the climate favouring the idea, I resolved to commence heating the retorts, fortunately, some days before the intended inauguration of the work, without the roof being covered, which I had previously done at another locality with success. Under ordinary circumstances, the retorts should have been ready for charging at the end of 48 or 60 hours, but day succeeded day, the heats being favourabe towards the evening, giving hopes of charging the following day, when no advance was made. Of course I attributed this to the neglect of the stoker, and resolved to be convinced by my own observations; and to my astonishment, from midnight to daylight, in spite of proper firing, the heats lowered in a very remarkable manner.

No time was to be lost, as tickets of invitation had been issued, the bishop of the province had consented to officiate, bands of music had been engaged, and refreshments ordered for the occasion (for that is the style of inaugurating gas-works at some places abroad); so, in the absence of any other material, I covered the roof (of about 25 squares) with calico, which was the work of a few hours, when the heats of the retorts reached speedily the desired point, and all went well. In this case the variation of the temperature did not exceed 15°, yet that was sufficient to prevent the retorts heating.

From this we learn the necessity of having the interior of the retort-house as warm as convenient with the comfort of the workmen, in order to prevent undue radiation.

I have had the temerity to dispute the necessity for the arch over the furnace, as well as the transverse walls which are found in large works, and I hope sufficient reasons have been given for my objections. I wish now to call your notice to the results.

As a means of comparison, I may observe that in the smallest gas-works the whole of the coke made is consumed as fuel, but as they increase in magnitude so does the quantity of coke available for sale, until reaching those of medium capacity, when 70 per cent. is sold, the other being employed for carbonizing. Judging from the gradual increase of coke sold from the smallest to medium-size works, we would naturally conclude that, in large works, where a greater number of retorts are set on a bench, where the heat is more concentrated, and where the retorts are double, the fuel account would be considerably more favourable than in medium works. This, I believe, is not the case, and in the absence of some better reason, I think it may be due to the arch so generally adopted in large works.

Unfortunately there are difficulties in the way of ascertaining the best settings of retorts on account of the variable quantity of coke yielded by different coals, and from the method adopted by managers in selling the same. In some places the coke is sold with rigid accuracy by measure, whilst in others it is delivered by weight, and others again without due regard to its value. Under these varied conditions a proper estimate cannot be obtained, nor can a full and correct estimate of any description of setting be arrived at.

But on considering the operations of works generally, there is the fact that large works do not produce a more favourable fuel account than smaller establishments. Of the cause of this I have ventured to give my opinion, for whatever it may be worth.

In conclusion, I must apologize for expressing opinions in direct opposition to the practice as usually followed; but, having given my reasons, I think there is room for reflection.

I submit that a proper consideration of all the points referred to is indispensable for economical carbonization, and more particularly in dispensing with the arches over the furnaces, represented in figs. 2 and 3, as well as the cross-walls for supporting the retorts, which must of necessity impede the passage of the caloric, and, consequently, increase the fuel account. Further, by dispensing with these, greater simplicity is attained, and the cost of construction reduced very considerably; but this is as nothing when compared with the daily economy derived by giving every facility for the direct conduction of the heat. I may also observe that unsupported retorts are very generally employed on the Continent, and, I believe, in Scotland, where clay retorts, we may say, were carried first into practical operation. The question may, therefore, naturally be asked, why are these cross-walls retained in England? and I think the answer will be, "Imitation."

I am aware that many attach but little importance to the damper. To these I advise immediate attention to that point, which must result in a more satisfactory fuel account.

My subject is very comprehensive. Much more might be said thereon; but, having reached the limit of time usually allotted for communications, I conclude with my sincere thanks for your kind attention.

A Member asked whether the No. 1 setting was a real or theoretical one. From his experience of clay retorts, he much feared that the duration of a setting of that description would be but very short. Perhaps the writer would say what the life of such a setting would be.

Mr. Douglas, of Waltham Cross, said he believed in having very little setting about clay retorts. Some 30 years ago, when burning cannel coal, he found that he could not put in any brickwork at all. In using Newcastle coal it was a little different; but to get high heats, and charge every three hours with cannel coal, very little, if any, brickwork should be employed. Another remark he would make—viz., that it was not a good thing to keep retorts long in. He made up his mind 20 years ago, and further experience had confirmed his opinion, that if a retort worked two years it was time to take it out, as he could make more gas with a new retort than an old one.

Mr. Stout said he had 156 retorts set on the principle described, and had worked them for years. The heats were more regular with settings of six than settings having a seventh retort in the centre, and the quality of the gas was also better. He believed the endurance also of such a setting was greater. In answer to the president, he said he had no cross walls.

A Member said he had travelled a great deal in America, where the retorts were usually set in beds of sixes on this plan, with cross walls and an arch over the retorts. The heats there were very uniform, and the production of gas good.

Mr. Paterson, of Warrington, expressed the pleasure with which he had listened to the excellent paper just read. As to the principle adopted by the writer, he might say that he had commenced the working of clay retorts about five years ago, and his experience was that the less brickwork employed in the interior of the bench the better.

Mr. Smith asked the thickness of the retorts referred to by the writer, and whether he had had any trouble with pieces dropping out, after the first season of working.

Mr. Fraser, of Inverkeithing, said he did not intend to say much, having attended more with the view of learning, and from a desire to pick up information from those who had used clay retorts, so that, on a knowledge of proved defects, he might apply himself to provide a remedy. Some people, as the writer observed, were anxious to get clay retorts cheap; but if they would insist upon that, they could not have them good. At the same time, he believed that the makers of retorts throughout the kingdom would be anxious to have any defects in the manufacture pointed out, and would endeavour to cure them. He questioned the fact stated by the writer, that retorts were made better in Belgium than in England. He was sure the British retort makers would be willing to accept a challenge to produce goods of at least equal quality to any that could be obtained from abroad.

Mr. Frith, of Runcorn, said he could not do with so small a quantity of brickwork as the writer appeared to be able to do. He could do with less brickwork about segmental retorts than with clay retorts made in the whole. He was a believer in the old-fashioned retorts of that description, not only because of being able to dispense with much of the brickwork, but because there was less leakage from them. A writer in the Journal had stated that he was opposed to segmental retorts in small works, because they were not capable of sustaining the varying temperatures to which they were exposed. But he (Mr. Frith) was of opinion that it was from their very capacity to bear such varying temperatures (which certainly ought not to exist, and might be avoided with a little care) these retorts were specially suited to small works.

Mr. Stone, of Weymouth, said in the South of England there were several works, within his knowledge, which had nothing but the vertical flues, with 9-inch furnace walls and two other partition walls, and with this setting they obtained between 5600 and 6000 feet per mouthpiece in 24 hours. The use of coke was not excessive, and the quality of the gas was 14 candles. The retorts were round-cornered D's, 20 by 14, and 9 feet long. The life of his own retorts was about 15 months, constant work.

Mr. Hislop, of Paisley, said he observed that the author of the paper allowed a very considerable area between the two vertical rows of retorts. This was admitted to be certainly an advantage, as it gave the gases passing up time for combination, and he had no doubt that the results were improved thereby. With reference to the manufacture of gas in Scotland, he would say that this method would not suit their purpose, inasmuch as the heats were so intense that he was afraid the retorts, as represented in the diagram, would be destroyed in two or three months. It would be necessary to have an arch at least between the centre retorts. Instead of the flat bricks between the top ones, which he believed would crack and break down, he should substitute an arch of 4½ inches. If that were done, he thought the system would work very well. In Scotland it was the rule not to exceed three retorts in one oven. In his own practice he had only two, one above the other. The heat passed up to the top, and then back two or three times, so that he got as good heats in the top retorts as in the bottom. He had tried various systems of setting, but had fallen back upon these as giving the best results. He had been using D-shaped brick retorts for a considerable number of years, and found they gave entire satisfaction. His retorts were 26 inches by 15, and 8 feet long. His make was three-quarters of a million per day.

Mr. Richards briefly replied. He said, in answer to the first question, that the setting he had exhibited was not a theoretical setting, but one that was being carried out in practice daily. He maintained that clay retorts could be made as durable as those of cast iron, if not subject to rough usage. No doubt with proper manipulation, they could be constructed as well here as in Belgium.

At the evening sitting the following lecture was delivered on

THE DIFFERENT QUALITIES OF IRON AND STEEL: THEIR MANUFACTURE AND APPLICATION.

By Mr. W. Mattieu Williams, F.R.A.S., F.C.S., &c.

As you are, of course, aware, the subject for this evening is "The Different Qualities of Iron and Steel," a subject of considerable magnitude, and which might very well occupy a great deal more than one evening. I shall endeavour to get through as much of the subject as I can, or rather, to run through the whole of the subject, dealing chiefly with the more important practical questions, and rather lightly passing over the theoretical questions, although some of them must be to a certain extent touched.

To begin with, there is an apparent contradiction in this very title, "different qualities of iron," because iron is one of the metallic elements, and chemists would tell us, and rightly so, that the elements, more particularly the metallic elements, are constant in their qualities; gold is gold, tin is tin, and copper is copper, all the world over. One sample of gold is the same as any other sample of gold, or of tin, or of copper, and so on; yet here we find such great differences in iron. Now this arises from the very simple fact that what we commonly call iron is a mixture of iron with several impurities—a greater or lesser number of impurities; actually pure iron is something almost unknown. If it has ever existed at all, it has only been in minute quantities as a chemical curiosity; but for practical purposes, and in practical manufactures, we are quite unable to obtain pure iron; and if we did obtain pure iron it would be of very little use.

In the first place, supposing we had a piece of pure iron, and put it into the fire, and made it red hot, if I am right in what I understand to be the properties of iron, it would at once be spoiled; it would become oxidized to such an extent as to be rotten. I hope to be able to go a little further into that presently, as we proceed. Iron, then, varies in quality, and this is the case more particularly with modern iron. Modern iron is more impure than ancient iron. It is rather curious that our improvements in the manufacture of iron have resulted in obtaining a very inferior article, in very large quantities, to begin with, and then adopting very skilful methods of removing these impurities. The reasons for this I may just explain. The old primitive ironmakers, and those of India and some other places, still—for instance, in the Pyrenees—used pure, or nearly pure, oxides or carbonates of iron. Their ores contained very little impurities. They also used fuel of considerable approximation to purity. They used charcoal, and by simply heating oxide of iron with charcoal, the oxygen of the iron passes over to the charcoal; that is, the oxide is reduced, and we get the iron nearly pure—not quite pure, but always combined with more or less of this charcoal or carbon that is used in its reduction. Hence it is that the ancient iron is usually of a very good quality, although made by exceedingly simple processes; and some iron still made in Hindostan is of very fine quality, and it is made directly. Now, of course I need not tell you why we have been obliged to discontinue that. In the time of Queen Elizabeth there was a great outcry, and laws were made, on account of the disforesting of England through the use of charcoal for making iron. We soon came to the end of that, and we were compelled to cease to be

ironmakers, or to use that material which exists in such abundance under our feet—viz., coal.

Now coal contains several substances which are injurious to iron, which iron combines with readily when it is heated; and hence it is that for another reason as well—viz., in order to get the large quantities we now require, we are driven to use very complex iron ores, instead of using only the nearly pure oxide, such as the magnetic oxide or red hematite. We now use complex ores of iron which have been deposited along with sedimentary matter—earthy impurities which contain silicon and a variety of things; and unfortunately they also contain a certain amount of organic matter, which is the most troublesome part of all. We use these ores, and some of their impurities remain after the first process of manufacture is carried out—a considerable proportion—and some of them remain even to the end, and we cannot quite get rid of them.

For the purposes of this evening, I will classify iron into five kinds, including steel. First of all we have the pig iron, or crude iron. I am now speaking only of modern iron, and pig iron is a modern substance. Next we have refined iron; next to that, puddled iron, that is malleable or wrought iron, as it is called, which is the nearest approach we get to pure iron; then steel, the old-fashioned steel, and besides that we have now a new-fashioned steel, a very important substance intermediate between old-fashioned steel and wrought iron. This is now coming very largely into use, and I will call it, for want of a better name, semi-steel, or homogeneous metal. I will proceed, as far as time will permit, to describe each of these. First of all, pig iron, though I shall have very little to do with that now, because in the condition of pig iron it is but little used, excepting some of the better kinds, which are used for castings directly as it comes from the blast furnace. I need scarcely tell you how pig iron is made. The iron ore, along with coal or coke, or a mixture of coal and coke, and a certain quantity of lime, is put into a tower, like a furnace—a blast furnace, which is heated from below. When it is in full work, there is the heated mass reaching from the lower part up to the top, and some furnaces reach 80, 90, or 100 feet in height. There is a blowing apparatus below, by which air is blown into it. This compound of iron ore, mixed with lime and coal, is put into the furnace, and the coal, of course, is heated. The function of the coal is twofold—first to heat the iron ore, and, secondly, to take away its carbon. If our iron ore were pure, and the coal were pure carbon, this process would be a very simple one. We should stop at an early stage of the process, as soon as we had obtained the iron; but in our ordinary iron ores there is a large quantity of silicon. Now, silicon combines with metals, and forms a glassy substance; or rather, silicon combines with the oxides of metals, and gives us glass itself. Of course, any glassiness in the property of iron would be obviously mischievous. We have to get rid of this silica, and the mode of doing so is to present, with the mixture of iron and silicon, a substance which has a greater affinity for the silicon, which is more basic, and has greater affinity for the silicic acid, and more disposition to form glass than iron itself or oxide of iron. We might use soda or potash, but these would be expensive. Lime is almost as effective, and, being abundant, is used. The function of the lime is to combine with the silicic acid, and to form a lime glass. The workman calls it fluxing, because this metal glass smelts at a lower temperature than iron itself. Here is a diagram which gives you some idea of what takes place in a blast furnace. The upper part is hot, and in this zone reduction begins; that is to say, the oxide of iron is being converted into iron. Then the limestone is decomposed, and is converted into quicklime. Sometimes that is done outside the furnace, and the lime is put in as quicklime. The reduction goes on down to a certain point, and here a curious thing occurs. Just at this part we get spongy iron, but this spongy iron is in a solid state; the minute particles are all mixed up with the impurities. The iron there is tolerably pure, but then it gets to a higher temperature as it sinks lower down, and here commences a very bungling sort of process, which damages the iron. Mr. Lothian Bell has termed this the zone of absorption, because here, unquestionably, the spongy iron begins to absorb those impurities that afterwards have to be removed by a somewhat complex process. This absorption goes on down a certain depth in the furnace. If you took a sample of iron out above this, separating the iron by a magnet or otherwise, you would get tolerably pure iron; but if you get it further down, you find it is combined with sulphur, with phosphorus, and is very impure and bad. Lower still we come to a zone of fusion. This iron, which is rendered by absorption impure, becomes fused, and when it begins to fuse, these silicates separate—the more fusible silicate of lime separates, and the more heavy metallic or pig iron mixed with impurities falls down, and we get fluid pig metal at the bottom, and fluid slag above. The fluid slag or cinder is run off from the top, and the fluid metal is run off from below into long channels. A long channel is formed in sand, which is called a sow, and the little channels that run out on each side are called pigs, and thus we get pig iron. The people in the Black Country are very poetical and metaphorical in their use of language. If I had time to go into the present state of invention in the matter of iron, which is exceedingly interesting, I might tell you that an immense amount of inventive activity is proceeding now, and has been for a long time, in the iron trade, and the great problem that is now being attempted to be solved is how to stop the process just at the stage where reduction is completed. There have been a dozen or two patents lately taken out, and a great many thousands of pounds have been expended in endeavouring to avoid this absorption; but I must not go into this at present. But the fact is, the great bulk of iron that we produce is thus rendered impure, and has to be purified afterwards. You can understand that when you have in the spongy iron millions of little grains of pure iron surrounded with millions of other grains of impure material, to pick out the little grains mechanically would be rather a difficult problem—more difficult than to make them combine chemically, and afterwards to separate them by chemical agency. Mr. Larkin and others have attempted mechanical separation by sifting with magnets. This may be developed at some future time, but at present we have to deal with what is actually going on—that is, the manufacture of this pig iron. I have here a table of the composition of such pig iron. That of the first column is rather an impure pig iron; the next column is something like the medium sample. The first is Cleveland iron; and it is a curious thing which has often struck me, that the two great centres of British iron manufacture are South Staffordshire and the Cleveland district, and those two places are distinguished from all other places in the world where iron is made, by having about the very worst raw material and the greatest difficulties to contend with. In Cleveland they get very bad stuff indeed. As I have said before, phosphorus is a very bad ingredient, and there is much phosphorus in the ironstone of the Cleveland district; but there are Yorkshiremen there as well as phosphorus, and, therefore, phosphorus has been conquered; and I think the fact goes to remove the idea, which is very prevalent, that England is dependent so much on her mere material wealth. I believe England is mainly dependent on the industrial skill of the people, and when that becomes combined with a greater degree of education and scientific intelligence, we shall still go on when all our coal is gone. However, not to run away from the subject, we have these various impurities in the pig iron, which are shown on this table:—

Combined carbon	0·80	0·41	1½ to 4 per cent.
Graphite	1·00	1·70	
Silicon	2·23	2·05	1 „ 4 „
Sulphur	0·27	0·24	⅒ „ ¾ „
Phosphorus	1·30	0·35	⅒ „ 1½ „
Manganese	0·71	1·92	0 „ 2½ „
Iron	93·69	93·33	90 „ 95 „

Before going further, I think it would be well to take these impurities *seriatim*, and point out the effects they have upon iron. First of all, suppose we have a pig containing a large amount of combined carbon—and I have known some to contain as much as 4 per cent.—that pig iron will be white in appearance, and excessively hard, harder than steel. I want particularly to impress this upon a good many who have not gone into the particulars of this subject, because there is an idea very prevalent that the value of steel is just proportionate to its hardness, and mere hardness has been accepted very often as a proof of goodness in steel. That is a great mistake, because you may have a pig iron worth in the market 50s. per ton, which shall be harder than steel worth £50 a ton, merely because it contains a larger quantity of carbon. The effect of the carbon upon iron is to harden it, and to render it brittle. I shall have to go more particularly into that when we come to the subject of steel.

Now we come to silicon. The action of silicon upon iron is very similar to the action of carbon. It hardens it and renders it brittle—it makes it glassy. You know glass is a very hard substance, but by no means tough. What we want in useful steel or iron is toughness. In many cases that is far more important than hardness. Now, silicon gives hardness, but destroys toughness, and it does this more than the carbon does. Carbon gives hardness at the expense of toughness; but a certain degree of hardness given by a certain quantity of carbon is not attended with so much brittleness as a corresponding degree of hardness produced by silicon. Silicon hardness means a greater degree of brittleness than carbon hardness. Then there is another great difference between the hardness conferred by carbon and that due to silicon; a given compound of iron and carbon is capable of receiving varying degrees of hardness, and thus has the invaluable attribute of cutting or otherwise working itself. If such a compound is heated and suddenly cooled, it becomes very hard and brittle; but if it is heated and slowly cooled, it becomes tougher, and not so hard. It admits of hardening, softening, and tempering. That is the characteristic property of steel. With silicon that is not the case; or if it is the case, it is so to a very slight extent. A certain degree of annealing is possible, even with glass; but not to nearly the extent as with steel.

Now we come to sulphur. What does sulphur do to iron? A very small quantity of sulphur will do a great deal of mischief. One-tenth per cent. will make a very appreciable difference. A thousandth part, more or less, will alter the properties of iron very materially. The effect of sulphur is to produce what the workman calls red shortness—that is, iron containing sulphur is brittle when it is hot. Suppose we had a piece of iron, containing a considerable quantity, say 0·25 per cent., of sulphur; the other impurities being removed, it would bend when cold, and for some purposes, where it was only used cold, it might be good enough; but directly you try to forge such iron as that, make it red hot, and begin to hammer it, it cracks all round where it is hammered; it is rotten when it is red, or red short, as the workman calls it. That is the principal mischief done by sulphur.

Phosphorus is even still more mischievous, for some purposes, than sulphur. Phosphorus gives cold shortness. Iron containing a considerable quantity, say 0·2 per cent., which would be a very large quantity in finished iron—for even 0·1 is far too much; but supposing it has 0·2 per cent., that, unlike iron containing sulphur, would bear a good deal of bending when red hot, but when cold it would be brittle and hard. It would be steely in hardness; but it would have steelyness, accompanied with a great degree of brittleness. I have tried a great many experiments upon this, and I find that, as regards hardness, phosphorus has three or four times the hardening power of carbon. Iron, with 0·3 per cent. of phosphorus, will be as hard as iron containing about 1 per cent. of carbon; and only looking at this question of hardness, some eminent chemists, French chemists more particularly, have stated that phosphorus is an essential in the manufacture of steel, and that it improves the quality. This is a very great mistake, and it is now pretty generally recognized that phosphorus is the most mischievous constituent of steel. It gives a greater degree of brittleness. A very small quantity of phosphorus, indeed, renders it unfit for the better qualities of steel, and quite unfit for the manufacture of tool steel.

Manganese is a puzzling substance. Some say it improves, and some say it does not improve iron. I have tried to get at the bottom of this puzzle, and the conclusion I come to is this. I do not think manganese does improve iron; but in the course of the manufacture of iron, in the fusion, the manganese does some kind of work, some kind of purification, which brings out a better result than if there were no manganese—that is to say, if you take a pig iron rich in manganese, and use it for puddling, or work it up in other ways, the manganese improves the quality of the finished iron; but we do not find it remaining in the iron. Steelmakers use manganese in the melting, and find they improve the steel by the addition of it; but yet the best steel contains no manganese. It disappears, goes away in the cinder. It seems to be of some use in removing some other impurities, and I think it has a great deal to do in removing the silicon; but I will not speak positively on that question, because it is still open to further investigation.

Then there are other impurities I have not mentioned, because they exist in very small quantities, and have little effect. A little calcium, a little copper, and a little arsenic even, occasionally are found; but these I need not go into particularly. Some kinds of castings may be made directly from pig iron, especially pig iron of tolerably good quality, with a moderate amount of phosphorus, and not too much silicon. But there is a mode of removing some impurities, which was once very largely adopted, and is still adopted, to a small extent, and that is refining. Pig iron is refined by simply melting it and blowing air upon it. There is a diagram showing the operation. There are tubes on each side of the furnace which blow air upon the fused iron. The open finery was, in old times, a very important apparatus. Supposing we were making pig iron, if we used a blast furnace, and used charcoal only and the pure ore, we could then get pig iron which would contain very little phosphorus and sulphur; because I should mention that the phosphorus in our iron comes chiefly from the ores, and sulphur from the coal. If, therefore, we used pure ores and pure coal, there would be very little phosphorus or sulphur; and by simply treating it in a refinery, we should get a very fair quality of iron, such as was obtained before Cort invented the puddling furnace, not so very long ago. The action of the refinery furnace is simply this. It burns away some of the carbon, and burns away some of the silicon. The air that comes upon the melted iron produces combustion, and the most combustible of the constituents of the mixture are the first to burn. By simple combustion we thus get rid of the silica and the carbon, and get nearly pure iron, or we may, if it is free from silicon, at once produce steel by that means; but we do not get rid of the sulphur and the phosphorus—they still stand in the way. To get rid of the sulphur and the phosphorus, a puddling process is adopted, and is the most effectual. There are other means, but the puddling furnace, or the closed finery, which was invented by Cort, is now most largely used. It is a reverberatory furnace. Heat is applied at the top of the metal, and as soon as the mass is melted, the workman, through a hole in the door, stirs it about. It is an exceedingly simple business, nothing but melting and stirring; and yet by that melting and stirring, as performed by a skilful puddler, he can do what no chemist is able to do without him. That is a very curious thing. A good puddler will take a very bad pig, and by skilful management will produce a good quality of iron from it. Chemists have tried to do the same by chemical agency alone, with doubtful success; but the puddler does it quite successfully by simply stirring it. I think it is a kind of washing process. He melts it, and begins to grope a little about the bottom first with his rabble. Then as soon as it is melted, it begins to "boil," and gas is given off. Carbonic oxide

spurts out from the surface; at this boiling stage he works with very great rapidity, and there is a violent oxidation process going on; then it becomes pasty and granular—comes to nature, as he calls it; and then he gathers these granules of iron together, which are less fusible than the cinder or slag that surrounds them, and works them up into a ball of spongy iron; in fact, he gets the iron back to the condition it had at the upper part of the blast furnace. Then he gathers it into a ball, takes the ball of spongy iron out, and it is placed under a tilt-hammer, a steam-hammer, or in a squeezer, and is squeezed like a sponge, to squeeze the juice out of it. There is a kind of juice in this ball, which consists of the more fusible impurities, and by putting it under a steam-hammer, or a tilt-hammer, the juice is squeezed out. There is a diagram of a rotary squeezer, in which the ball is put in at the large side, and gradually worked round, and the liquid fusible matter is squeezed out from between the particles of infusible iron (for pure iron is quite infusible in any ordinary furnace), and these infusible particles are welded together, and form the puddled ball. There are still, however, some of the fusible impurities entangled in it, and to get rid of these, the iron is beaten, rolled, run through rollers, and sometimes cut into plates; sheared, piled, again hammered, and squeezed, and every time it is hammered and squeezed, some more of this liquid matter is squeezed out of it, and the iron becomes tougher, more pure, and less glassy, and, at last, we get by these processes of washing in the puddling furnace and wringing in the squeezer, and hammer and rolls, the finished iron. By these mechanical means we squeeze out the impurities, and we get the tough metallic infusible iron. In all these processes the iron is not melted. Pig iron can be melted by the aid of the silicon, sulphur, and phosphorus impurities, because they all render it more fusible; but when you get them out, the infusible substance which remains behind is properly called wrought iron, because it has been wrought or worked considerably to bring it to this condition of malleable iron, that may be rolled and hammered, and if it is good, can be moulded to a wonderful extent without melting.

Here is an example of what can be done with good iron. It is a vase which was beaten out from a circular piece of plate iron. You can easily understand that a great amount of toughness is necessary to do that; and here is a still more remarkable specimen, made out of a piece of sheet iron, brought up to these very narrow dimensions. This little bottle was exhibited in one of the first of those exhibitions of manufacture which preceded the Exhibition of 1851. When the Prince Consort was going through that Exhibition, he was not told what he might expect to see, but he took up this identical bottle, and he was more struck with that than with the most magnificent ornamental products, because he knew something about it. He really had a great amount of technological knowledge; and when the Birmingham men saw him take up that bottle, they said, "He knows something about our work," which we did not expect. Here is a piece of iron tied in a knot when it was cold. The properties of iron, when it is obtained nearly pure, are toughness, elasticity, and a considerable amount of tenacity. For structural purposes, where iron is liable to be bent, or where it is subject to vibratory shocks, there the greatest amount of purity is demanded, and especially freedom from phosphorus. But the tenacity of iron is not so great when measured by direct pull as the tenacity of steel. We get, then, pure iron, which differs from the iron I have previously described, that is, from pig iron, or refined iron, both of which are used for castings, by its greater toughness, its greater softness, and, of course, its less brittleness. I have one or two examples of extremely tough iron. Perhaps, the case where the greatest difficulty is overcome in making tough iron is in the manufacture of armour plates. You know the purpose for which they are intended, and the enormous plates, sometimes 14 inches thick, with which armour-plated ships are coated. Those are tested at Shoeburyness by being put up and fired at, and there is a competition between the cannons and the plates. As soon as you make an improvement in the gun, then a thicker plate is made to meet the requirements. One might, at first suppose that a steel plate would be best, but that is a great mistake; if you were to coat a vessel with steel you would have a very bad ship indeed. If you put a plate of steel up at Shoeburyness, and fired against it with those wonderful guns, it would be shattered into fragments. The first requirement is toughness, and iron should be almost leathery for that purpose, so that the shot might make a great bulge, a great dent, or might even stick half way in it, and there remain. That is the kind of iron that is wanted for that purpose—toughness carried to this great extent; and the great point in the manufacture of armour-plates is to just reach that point when the silicon is squeezed out, and the carbon just oxidized. There may be a little sulphur, provided there is not so much as to prevent the working of the iron in the manufacture, because a little sulphur in the cold plate, some say, is an advantage. But certainly, if there is a small amount of sulphur, it will, to a certain extent, neutralize the action of the phosphorus. But the silicon and the carbon must be removed, and, if possible, the phosphorus. That is done by continually working. Good iron is used to begin with, and it is rolled and re-rolled. The way in which an armour-plate is made is this. It is made of puddled iron. The spongy balls are taken out, several of them welded together, and rolled out into a thick plate. Several such plates are piled one above the other, forming "a mould," as they call it. This is heated over again in a very large furnace up to a welding heat, but without burning it. Then it is rerolled, and several of these are piled together to make a still larger plate; these larger plates again are put together, welded, and rolled together to make a still larger one, and thus it is heated and rolled several times, and every time it is rolled there is something squeezed out, and if that rerolling is carried just to the right point, you get the best quality of iron, but if you go a little beyond it it is injured. Some interesting experiments were made at Sheffield whilst I was there, on the number of times an armour plate would bear rolling. It was found it went on improving to about five, six, or seven reheatings, but directly you passed that, then it began to deteriorate. The reason was this—they did not know the reason, but I worked it out—that carbon in iron protects it from oxidation. Chemists will understand exactly what I mean; carbon, when heated, has a greater affinity for oxygen than iron, and as long as the carbon is there, when heated at a certain temperature, it acts as a protection to the iron, and it will even take the oxygen away from the iron, but when you have gone on working and reworking, and gradually reheating, you get rid of all the carbon, and all the silicon, which also serves as a protector; you then come nearly to the condition of pure iron; then, directly you make this hot, it begins positively to burn; combustion takes place whenever iron is red-hot and exposed to the air, but so long as something more combustible is included that will save the iron from oxidation, either carbon, silicon, or manganese will do this; but when these are all gone it begins to burn. This is shown by the fracture. Some armour-plates were found to have little black grains in the fracture, and to be rotten to a certain extent, and every additional rolling made them more and more rotten. To show what an armour plate is capable of doing, here is a shaving from an armour plate taken off the thickness, and here is another, and you must see the iron is very tough for such a shaving as this to be formed from the iron without breaking. But we sometimes require hardness, and we have even to sacrifice toughness for hardness, and that is just the delicate point to know where to stop to make the iron hard without sacrificing too much of the toughness. This question of how far we shall go in the direction of hardness, and how far in the direction of softness and toughness is a question of great practical importance, and that brings us at once to steel. Many improvements are being made in the puddling furnace. There is the rotary furnace and others, but, at present, the poor puddler has not been superseded. He has been threatened for the last 20 years, to my knowledge; his last days have come, they tell us. One invention comes over from America, which is going to roll all iron in a drum; another brings out a chemical invention, but still the puddler is going on—he is not extinguished yet. I will not say that he never will be, but he has a little longer yet to exist. Seeing the ingenuity of these men, I am sorry I have not time to say a little more for them, for I have a very great respect for puddlers, and for all sorts of illiterate men who know a great deal which they do not know how to express. Any one who will go, as I have done, and watch the puddler at work, will find there is a great deal to be learned from him. I was very much struck with that once. Some gentlemen were sent down from London to give instruction to the puddlers in the Black Country, and one particular lecturer (it was rather amusing), began by saying, "Look at all these black clouds of smoke here; there is a shocking, abominable waste of fuel going on." Whereas this gentleman, who was supposed to know all about it, was ignorant of the very first rudiments of what he was talking about. The puddler never makes black smoke when he wants heat. He could have taught something to the Fellow of the Royal Society who came down to lecture him, if he had known how to express himself. When these black fumes came out, it was at the time when black volumes of smoke were necessary—when he had a hot ball ready to bring out; not when a great amount of heat was required, but when "unburning," to use a capital expression of Dr. Odling's, was wanted; it was then that the black volumes were seen, and there was a good reason for them. If you watch a puddling furnace, you will see at one time dense volumes of black smoke, and at another time a bright flame, and you have only to look at the top of the chimney to know what the puddler is doing, if you understand puddling. When the bright flame is coming out, that is when the melting is going on, when he wants heat. But directly he has reached that stage at which more oxidation would do mischief, he uses some most ingenious contrivances, which I cannot stop to describe, for preventing combustion, and they prevent oxidation. I could give you the titles of half a dozen books on chemistry where you see sections of puddling furnaces like this diagram; one of the very best books, "Miller's Chemistry," which is a splendid book, has a picture of a puddling furnace which any puddler would laugh at if he saw it. This lecturer from the Royal Society had a diagram of a puddling furnace when he was talking about puddling, and the men said, "That is a pretty thing. He couldn't melt iron in that furnace"—in fact, they laughed at him, and all that he had to say afterwards was lost upon them.

Now as to the manufacture of steel, I should like to define the term steel, but it is no easy matter. What is steel? It is a question which has been frequently asked, but, of course, the meaning of any word is that which is accepted as its meaning, and the meaning of steel has altered of late. Formerly one might say that a mixture or compound of iron and carbon, varying from 0·5 per cent. to 1·5, is steel. Such a definition was given; and very false definitions have been given besides, such as saying that it is something intermediate between pig iron and wrought iron. That is a mischievous mistake, which has led a great many people into trouble. If it were merely intermediate between pig iron and wrought iron, all you would have to do would be to melt the two up together, and you would have steel. There was a time when that might be done—when pig iron did not contain so much sulphur and phosphorus. Then if you got pig iron merely containing a large excess of carbon made from pure oxide of iron and pure charcoal, and if you mixed that with wrought iron, you would at once get steel, and that method was adopted; or if you simply blow air upon it when red hot, and keep it slightly agitated, you would oxidize sufficient carbon to bring it down to steel. Steel then is a compound or mixture of iron and carbon. If the iron be pure—for that is essential—the quantity of carbon that may be added to it, and allow it to be steel, will reach as much as 1·5, 1·75, up to 2 per cent. When you pass that, you get a substance which you are unable to weld, and that gives a fair line of demarcation. When it is no longer weldable, we may fairly say it will not bear the name of steel. There are different degrees of hardness of steel—very hard steel, hard steel, rather hard steel, mild steel, and soft steel, and so on. These degrees just run into each other according to the quantity of carbon contained; but the essential distinctive property of steel is this, that, if it is heated to a red heat and suddenly cooled, it becomes very hard, but if it is heated to a red heat and slowly cooled, it becomes softer. This is a most important property, because it gives us a material which can cut itself and can work itself. When that was discovered, it was an enormous step in industrial progress. When it was found that you could make a hammer of steel, which should beat out the material of which itself was made—when you could make a file, or a saw, which should cut the material of which itself was made merely by altering the condition, by a difference in the mode of heating it—a grand discovery was made; and you can only get that, as far as we at present know, by combining carbon with the iron. All these other things—silicon, sulphur, and phosphorus—harden iron; but their hardening is not attended, to any notable degree, with this property of being made hard and soft. But that is not all. You have different degrees of hardness in the same steel. If you take a piece of good Sheffield tool steel, containing about 1·25 or 1·50 per cent. of carbon, such as the best cast steel, and if you make that red hot, and then cool it, you get it into a very hard state—in fact, too hard for most purposes. It would do for a file, perhaps; but for most purposes you require to soften it a little, and you can soften it to various degrees, and there is a beautiful property by which the workman can test the degree to which it is necessary to heat it. If he makes it hot after it has been hardened, and then allows it to cool gradually, he can get different degrees of softening, down to that degree of softening which you would get by making it red hot. The property by which he can tell the temperature to which he has to raise it is, that a film of oxide forms upon it, and that film changes in thickness, and changes in colour; and I may as well mention the changes that take place. The first colour that appears when you warm it is a pale straw colour, and that is at about a temperature of 420° Fahr. You might get that either by direct heat, or by putting it in a bath composed of seven parts of lead and four parts of tin; or if you cover it with tallow, at that point when it will just begin to vaporize. Then the next degree is full straw colour. Of course, it goes on gradually; but that is about 450°, and tallow will just begin to smoke. Then there is what is called straw yellow, which is about 480°, and tallow put upon it would smoke more decidedly. Then you get a brown—"nut-brown," as the workmen call it—at a temperature of 500°, and it will cause the tallow to smoke and decompose decidedly. Then you come up to 30° more—about 530°—when you get a purple, and black smoke will then come from the tallow. Then you get bright blue, 580°, when the tallow will burn if a lighted taper is brought to it—it just flashes. A deep blue is next, 590°, when the tallow will continue burning. Then a blackish blue, and all the tallow burns away. After that there are no more changes of colour, and they are not needed. According to the purpose for which the steel is to be used, these different degrees of hardening are adopted. If it is a tool for cutting cast iron, or turning iron, it must be very hard, and the tool must have a very obtuse edge, almost square; because, if it were made more acute, the edge would break. That is tempered at a pale straw. A very pale straw may be used for that obtuse edge; and as you increase the acuteness of the edge of the tool you must get it softer and softer, and get more and more toughness, unless it is to be used for a purpose where there is little shock, such as a lancet, a lancet being always used for cutting something soft. Generally, a dark straw is used for a razor; and for a lancet, where a great degree of hardness is required, a straw colour is used. Files sometimes are left untempered, merely hardened; or they may be very pale straw; that would depend on the hardness of the steel. Tools for cutting brass are a full straw colour. Then the next degree, straw-yellow, is used for knives, dies, and articles of that kind; the fourth degree—brown—for scissors and knives, used for purposes where a more acute edge is required. Then purple is used for clasp

knives, such as gardeners use, and for joiners and carpenters tools, and for those used for cutting stone. Then blue is the spring temper—that is, where you want elasticity—as for watch-springs, chronometer-springs, saws, and swords—those which will bend round and spring back again. Pale blue is used for swords, and the deep blue for watch-springs; the last, the blackish blue, which is the lowest degree, is used sometimes for hatchets that are going to be used in very cold climates; because a hatchet that might be used for cutting down trees in England, if it were taken to Canada and used in a Canadian winter, would break immediately; it has to be tempered quite differently for that purpose.

Now then you see we gain toughness at the expense of hardness always. But, in order to obtain the greatest degree of hardness with the greatest degree of toughness, we require the greatest possible purity—that is, simply carbon and iron. I am sorry to say I cannot tell you how steel is made, for want of time—that is, not in detail. The old-fashioned Sheffield mode is very simple, and it appears very contradictory. First of all, the puddler takes all the carbon out of the iron, and then the steelmaker puts some of it back again. This is the process of cementation, and it seems very contradictory, but is necessary, as the carbon comes out in removing the other impurities. The bottom of the cementing furnace is shown in that diagram. Stone boxes are used, and a number of pieces of bar iron, about 3 inches wide by three-quarters of an inch thick, are laid in them with alternate layers of charcoal. Then it is all closed up, made red-hot, and the heat is kept up without the admission of air for something like a week or ten days, or even more, and a very curious change takes place—the carbon goes positively through the very substance of the iron, and finds its way to the middle. Graham's researches have shown how this occurs, though there is a greater amount of carbon undoubtedly on the surface; but, when the process of cementing is completed, if you break the iron right through you find carbon at the centre. It must become gaseous to do that, or something like it. Then you get what is called "blistered steel," the outer part being blistered, indicating the existence of gases which passed through the steel. This blistered steel is not homogeneous, the outside has more carbon than the inside, and is harder; it has, therefore, to be stirred up somehow. One mode that is adopted is to melt it together. You get a quantity of this blistered steel, cut it up, and melt it, and thus you get "pot steel," or "cast steel," which is the best of all which is produced—it is uniform in its structure. That, however, is an expensive process, the wear and tear of the pots being very great. Any one who visits Sheffield, must have seen garden walls made of old metal pots, and "Pot Square" is a very important place in Sheffield. These pots are made very carefully, and yet they wear out very rapidly, and there is a great deal of coal consumed in the melting, so that the steel thus produced is of the most expensive kind. A substitute for that is effected by the process of tilting and shearing. The bars are sheared, or cut into short lengths; then those lengths are faggoted together, a number of them are made red-hot, and hammered out by the tilt-hammer. The tilt-hammers move with very great rapidity. They keep up the heat, and even make steel hotter after it has been some minutes under the tilt-hammer than when it was originally placed there. By that means it is welded together, beaten out, then sheared again sometimes, and then re-tilted, so that you have shear steel, double shear, and even treble shear, according to the number of times it has been sheared. The object of shearing is simply to mix together the different hardnesses of steel, and, at the same time, to squeeze out a little of the silicon. The same takes place in the melting-pots; and there is a consequent improvement in the quality from the melting.

A great step has lately been made by Mr. Bessemer, although he made a great mistake at the commencement. I think it was Marshal Soult who said that the English were very stupid people, for when they were beaten they did not know it. It was something like that with Mr. Bessemer; he was beaten. He got a false theory and failed, but he went on working, and out of that false theory he came to something valuable. His theory was this when he began: He had taken the old definition of steel as being something intermediate between cast iron and wrought iron; that cast iron is a compound of iron, with 3 or 4 per cent. of carbon, and wrought iron contains none, whilst steel is intermediate between the two Then he said, "If I only blow air into this cast iron, or pig iron, and stop half way, I shall get steel at once." He tried to do that, and he failed over and over again. He took various kinds of pig iron, and he blew air through it by a very ingenious process. This diagram will give you an idea of his converter. It is lined with some substance which will bear a great heat, and when used is turned over horizontally, so that the melted metal will be along the side. Melted pig iron is poured into it, and while it is still lying on the side, air is blown through a number of apertures, each about three-eighths to half an inch across. It is then turned over, and the melted iron stands over these holes; but the air is blown through with such immense force that the melted metal actually rests upon the air; thus, in the Bessemer converter, while the blowing is going on, the metal rests, as it were, on a sieve of air, the air going up more rapidly than the melted iron can fall down; and thus an enormous quantity of air is blown through, and a tremendous combustion occurs. First of all, the silicon burns away, and next the carbon begins to burn, and with it the manganese, and if you go on far enough you burn the iron. The silicon is all burnt away There is no difficulty in getting rid of that, and there is no difficulty in getting rid of the carbon, but in all the first attempts he made there was still the phosphorus left, and sometimes a large quantity of sulphur. He got rid of some of it, but still a portion of it remained obstinately behind, and he could burn the iron away without getting rid of it. The result was that he produced a kind of iron free from silicon and carbon, but containing sulphur and phosphorus, and when that was placed under the hammer it cracked and crumbled away; in fact, it was rotten and worthless. That seemed to be like failure, but he went on and on, and, having tried a great many different kinds of pig iron, at last he found that by using very good pig iron, with scarcely any phosphorus and scarcely any sulphur, he could get, sometimes, a tolerably good steel, but he could not rely upon it; he could not tell when it would come out with enough carbon, and when with too much. But Mr. Robert Mushet invented and patented a mode of mixing *spiegeleisen* containing a considerable quantity of carbon with iron containing little or none. Mr. Mushet was unfortunate, and was just too late to complete his specification, and lost it, and Mr. Bessemer got the benefit of it; but I am glad to be able to say that I believe, although Mr. Bessemer was not bound to do anything for Mr. Mushet, he has really treated him very handsomely, and has given him a sort of royalty. However, that was the saving of the Bessemer process. This *spiegeleisen* is a peculiar kind of ore, which contains a large quantity of manganese and some 4 or 5 per cent. of carbon. First of all the iron is treated until nearly all the carbon is burned out. Then it wants a certain amount of carbon added to it. Suppose you want one-half per cent. of carbon: if you have 4½ tons in the converter, you have simply to add half a ton of *spiegeleisen*, which, by analysis, you know contains 5 per cent., and by mixing the two together you get the proportion required. When that mixture is completed, it is run into ingots, and cast like cast steel, and by this simple process you can obtain any required quantity of carbon. This has led to the introduction of a new substance. If Mr. Bessemer fails to make the best kind of steel, such as tool steel, he has succeeded in making a new substance, which may not do for swords, watch-springs, or cutting tools of the best quality (although I am sorry to say a great many cutting tools are made of it), but there are some other things made from it, such as rails, which are called steel rails, which are very successful. It contains a small quantity of carbon, from one-quarter to about three-quarters per cent.; and if the ordinary Bessemer metal, which is used for making steel rails, were charged with 1 per cent. of carbon, a very curious result would occur. If put under the hammer it would probably crush like a piece of sandstone, or certainly, if it contained 1½ per cent., the quantity of carbon it can bear depends on the quantity of phosphorus. If you get all the phosphorus out, you can put in 1½ per cent. of carbon. When a little phosphorus remains, you cannot put so much carbon in. But with a little phosphorus, provided you keep down your carbon, you can make a material which has properties intermediate between iron and steel; which has a considerable amount of the hardness of steel, and a considerable amount of the toughness of iron, and it has one very important property which iron does not possess, and that is why I dwelt a little longer on the manufacture of iron than I ought to have done. You will remember, when I spoke of the puddling process, I said that no fusion takes place—that ordinary wrought iron is a material composed of a number of granules of iron, which have been welded together and rolled out, not fused together, and the result is that some of the structure still remains, there is a fibrous structure, sometimes a laminated structure You have seen, I dare say, iron rails which have been worked a long time; they give out, and look like a birch-broom where they have been worn. Wrought-iron, when it is subjected to the kind of pressure that it gets in a railway, is crushed and sometimes laminates—that is to say, one layer will peel off where the welding is not quite complete. Now the Bessemer metal has the advantage of having all been fused; it is homogeneous and it is hard. Its surface is hard, and it has not that structure which is liable to be broken up. Hence it is well adapted for the wear and tear of rails and tires, and Bessemer rails will last ten or twelve times as long as ordinary rails, and the tires, if they are well made, will last too. They should be made a little harder than the rails, and in the Bessemer works the amount of carbon is carefully tested. Mr. Eggertz has invented a method by which one can determine, with sufficient accuracy for all practical purposes, the quantity of carbon contained in every blow. With an assistant, I have made as many as 40 determinations in a morning. We have had the ingots come in, and we have made 40 determinations, and sent the report in by three or four o'clock, and had our dinner in the meantime, without any difficulty, whilst, by the ordinary method, it would take a day or two to make one. With the help of this method the amount of carbon in every blow can be determined, and though you cannot always make sure of getting the right amount of carbon, the next best thing is to know how much, and to put aside each sample to be used for the purpose for which it is best fitted. For rails, about one-half per cent. of carbon is required—·4 to ·5. Tires to run on those particular rails ought to contain about ·1 per cent. more, because then the tire, being a little harder than the rails, the rail does not wear out the tire. If the tire is softer, the rail wears it out too fast. If you get a hard blow, that will do very well for ploughshares, or for spades or agricultural tools, where you do not want anything so good as fine steel.

Then there is another kind of material now coming into operation which is most important, which is softer than real steel, and it is difficult to find a name for it. The Government call it steel when it contains ½ per cent. of carbon. It is homogeneous metal, and is made either by the Bessemer process, or by the Siemens-Martin process, which is somewhat similar. It consists of the fusing together of the very superior pig iron, which is now made expressly for the purpose, called Bessemer pig, nearly free from phosphorus, with crude iron rail ends, cuttings, and so on, and working them up together. That makes a material of the kind I have here. Here is a bowl which is beaten out of it. It has some of the hardness of steel and some of the toughness of iron, or it would never have taken this shape. Here is a piece tied in a knot, and here is another specimen in which holes have been punched close to the edge without breaking the plate. This is very valuable for boiler plates when well made. But a good deal of scientific management is required in producing it. If you made a boiler with plates containing ¾ per cent. of carbon instead of ¼, you would get a brittle plate, and when a sudden shock came, away would go the boiler. But if the plates are selected, you can get a great degree of tenacity, nearly double that of iron, with the toughness of iron, so that a boiler 5-16ths of an inch thick is as strong as one half an inch thick of iron, and thus you have the advantage of a lighter and thinner boiler which will bear the same strain or pressure. For structural purposes also it is very useful, and is now being largely used for ship-plates by the Government. These bent and hammered specimens are all Government tests, and there is one curious feature about them, that, instead of demanding hardness, they insist on softness. People often speak of the steel as being very valuable if it will bear a pull of 60 tons to the inch. Now it would be easy to make steel that should do that, but the mere tensile strain, when applied gradually, is not a test of any value, and of so little value is it, that the Government specification now provides that the tensile strain shall not exceed a certain amount, that it shall stand a strain of 26 tons to the inch, and shall not exceed the strain of 30 tons to the inch; if it should exceed that it is sent back, or if it is below 26 tons. That is a wise arrangement, because the fact of steel bearing more than 36 tons shows that it has a degree of hardness that would be attended with a mischievous amount of brittleness. If it will bear a certain degree of bending, if it is not too hard or too strong, and it is homogeneous and well made, you have a material of the greatest importance, which is being largely used, and will, I have no doubt, be used to a larger and larger extent just in proportion as it comes to be understood. But here comes an element, and a very important element, essential to its successful use—that it demands a high degree of intelligence and knowledge. It requires strict integrity on the part of the maker, because it would never do to send it out without testing every plate. You must have a chemist connected with the manufacture; it is a scientific process, and must be conducted on scientific principles. If that is done, if those who use it understand it, then it will be an enormous benefit, but otherwise it will be very dangerous, because you may get it too hard or too brittle, or with a little too much phosphorus in it, and then most serious consequences may ensue. Suppose, for instance, you are building a steel bridge, much lighter than an iron bridge, if only one link in the chain is made a little too hard, if that goes, no matter how strong the others are, down goes the bridge, as nothing is stronger than the weakest part; so that it is necessary that the greatest care should be used. But if that care is used, and it is thoroughly tested, this material is of the greatest value. I am glad to say, and I think you will all be pleased to know, that the British Government, for some time past—I do not mean Disraeli's Government, or anybody else's Government, but the British Government—has scientific men connected with it in the testing departments, and their arrangements are admirable, and by their scientific testings they are able to use this material to an extent that no private firms have yet been able to use it.

I must apologize for the hasty way in which I have gone over this subject, and with that apology I must conclude. But if I have stirred up a little thought, and more particularly have directed your attention to this new material, as many practical men are around me, I think, perhaps, I shall not have wasted an hour and a half. Of course, as you know, well enough, I could not pretend, in an hour and a half's lecture, to make anybody familiar with any practical subject; for if one could, skilled men, like ourselves, would get very poor salaries. If anybody could learn a trade or profession in the hour and a half, gas engineers, &c., would be very cheap; so that you must not be disappointed if I have suggested some few things that may require further investigation. But if I have done that, and have at all interested you, I think your time has not been wasted.

The PRESIDENT: We have listened with great interest, and, I trust, not without some degree of profit, to Mr. Williams's very interesting lecture. He has spoken of the different kinds of iron; and if some of you have thought the lecture

very dry, and have wished to have a further acquaintance with Mr. Williams, I would advise you all to secure a book, which is at present out of print, but which, since I have come into the room, I have learnt is about to be reprinted. It is on a totally different subject, and is entitled "Through Norway with a Knapsack;" and I am quite sure, if you read that, you will be very much interested in it. I have much pleasure in proposing a vote of thanks to Mr. Williams for his very interesting lecture.

Mr. PATERSON: Will you allow me to second the vote of thanks to our learned lecturer. I think it is not usual, on an occasion of this kind, to propose a vote of thanks, but I am sure you will not disapprove of our doing so. The lecture has been one of most extraordinary interest, and upon a subject of very great importance to all of us. As engineers, we are all more or less engaged, and some of us very largely, in the construction of works in iron, particularly in roofs and in gasholders, so that a knowledge of the structure of iron is of very great importance to us. The lecture is one abounding in interest, and will be useful to us all when we have time to consider it deliberately; but there is one matter I should have liked the lecturer to have referred a little more particularly to, and that is, whether we have any means of ascertaining the quality of iron from the external evidences. There is a piece of iron here, gentlemen, which evidently bears a very large tensile strain. We have evidence of that by the knot tied upon it. But I should like to know whether, by taking the sectional area of this piece of iron, we could arrive at any knowledge of its quality from the molecular structure of the iron itself. I do not know whether I am right, but I believe I have heard that something like an approximate knowledge of the value of iron may be obtained from its molecular condition. If I am wrong, I hope you will put me right; but, at all events, whether I am right or wrong, I most cheerfully second the vote of thanks.

Mr. WILLIAMS: The question which has been put is a very difficult one. A great deal has been done in that direction, and a great many efforts have been made. One of the tests which has been applied for the purpose of finding out whether iron is homogeneous in structure is by treating it with diluted hydrochloric acid. You subject the section to the action of that dilute acid, and the acid attacks pure iron more rapidly than silicate of iron or carburet; hence, if the iron is of irregular structure, that irregularity is displayed by the corrosion of the acid. That is something of a test; but then there is this point to be remembered. Supposing you have a piece of iron that is uniformly bad, it may be uniformly acted upon, and if you relied on that you would be deceived. The question of tests is a very difficult one indeed; there is the cold bend and the hot bend, and various other methods. I may just say one word, perhaps, by way of warning. Perhaps, when you have a certain sample of iron brought to you, you will be told what it will do; it will stand such a test marvellously; but, if you are acquainted with the test, just ask the question whether it will stand the opposite sort of test; because you may have a man pushing a particular article who knows the article, and knows it will stand a certain test—he tests it by the one it will stand best. He says, "I will show you a splendid test for that particular iron." Another man will show you a different test altogether. The question is, will they stand opposite tests. Take, for instance, hot short and cold short. One will give you a splendid cold bend, but he never shows you a hot bend. Another shows you a hot bend without the cold bend. You want them both to be shown. There are tests of many kinds, for all defects in iron, and much depends upon the purpose for which it is wanted, because that which would be a good test for one thing would be of no value for another. You must bear in mind, then, what is the purpose required. The Government tests are admirably adapted to this end. It is always borne in mind what purpose it is required for, and the tests are devised accordingly; so that for one purpose one test is demanded, whilst for another, one quite different is required.

ANALYSIS OF POTABLE WATERS.

At the Meeting of the Chemical Society on Thursday, Feb. 17—Professor ABEL, F.R.S., the President, in the chair—the following paper was read:—

ON SOME POINTS IN THE ANALYSIS OF POTABLE WATERS.

By E. FRANKLAND, D.C.L., F.R.S.*

Eight years have now elapsed since, in conjunction with Dr. Armstrong, I had the honour to lay before the Fellows of the Chemical Society (*Jour. Chem. Soc.*, xxi., 77) an account of the chief determinations of water analysis. That account recorded the results of observations and experiments extending over more than two years, and embracing a thorough examination of the methods then employed in the analysis of potable waters, especially of the four processes used for the estimation of the organic constituents—viz., the "ignition," "permanganate," "albuminoid ammonia," and "combustion" methods. This examination showed conclusively that the last-named process was the only one yielding quantitative results in any degree trustworthy. The combustion and collateral processes then recommended have since been tested by many thousands of analyses of water from the most widely different sources, and I, therefore, venture again to return to the subject, and to communicate to the society the results of this enlarged experience. I do this with the less hesitation, because the further my inquiries into the influence of water upon the public health have extended themselves, the more have they convinced me that this technical application of chemical analysis is second to none in importance to the community at large. In the interests of the public health, and for the credit of applied science, the improvement of this branch of analysis is, in my opinion, worthy of the greatest efforts of chemists, and it is the hope of attracting increased attention to accurate, as distinguished from fallacious, processes in water analysis that has induced me to make this communication.

The two chief objects to be kept in view in the analysis of potable water are—firstly, the discovery of the evidence of past pollution by organic matter; and, secondly, the quantitative determination of present or actual organic impurity.

With regard to the methods for attaining the first of these objects, I have nothing to add to the descriptions given in the paper already referred to; but considerable difference of opinion having been expressed as to the importance of knowing the past history of any sample of water, as regards its pollution by organic matter, and even as to the possibility of ascertaining it with any degree of certainty, I may here be permitted to illustrate these points by the results of a more extended experience.

The past history of a water is made out chiefly through the mineral products of oxidation which the polluting organic matters have yielded, and which are still present in the water. Now these products are innocuous, and therefore it is obvious that if all kinds of organic matter behaved alike under the influence of oxidizing agents, such evidence of previous pollution might be safely disregarded; but it is almost superfluous to point out that there are wide differences between various kinds of organic matter, in regard to the rapidity with which they combine with oxygen; and of all kinds, that which is organized and living opposes by far the greatest obstacles to oxidation. The researches of Chauveau, Burdon Sanderson, Klein, and others, scarcely leave room for doubt that the specific poisons of the so-called zymotic diseases consist of organized and living organic matter, and it is now certain that water is the medium through which some at least of these diseases are propagated. It is evident, therefore, that an amount of exposure to oxidizing influences which may resolve the dead organic matters present in water, into innocuous mineral compounds may, and probably will, fail to affect those constituents which are endowed with life. Indeed, instances are not wanting illustrative of the persistency of the typhoid and other similar poisons when they are diffused in water and then exposed to oxidizing influences. One of the most striking of these occurred at the village of Lausen, near Basle, Switzerland.* It was investigated with much care and skill by Dr. A. Hägler, of Basle. In this healthy village, which had never, within the memory of man, been visited by epidemic typhoid, and in which even a single sporadic case had not occurred for many years, there broke out in August, 1872, an epidemic which simultaneously attacked a large proportion of the inhabitants. About a mile south of Lausen, and separated from it by the mountainous ridge of the Stockhalden, which is probably an old moraine from the glacial epoch, lies a small parallel valley—the Fürlerthal. In an isolated farmhouse situated in this valley, a farmer who had just returned from a long journey, was attacked by typhoid fever on the 10th of June. During the next two months, three other cases occurred in the same house, viz—a girl who was attacked on the 10th of July, and the farmer's wife and their son, who sickened in August. The inhabitants of Lausen were entirely ignorant of what had occurred at this solitary mountain farm, which was cut off from all communication with the rest of the world; when, on Aug. 7, ten of the villagers were suddenly struck down by typhoid fever, whilst, during the next nine days, the number of cases had already increased to 57, out of a population of 780 persons living in 90 houses. In the first four weeks, the number of cases reached 100 (or above 12 per cent. of the population); and altogether, to the close of the epidemic at the end of October, 130, or 17 per cent. of the population, were attacked, besides 14 children who were infected at Lausen during their summer holidays, and became ill after their return to schools in other localities.

The fever cases were pretty equally distributed throughout the entire village, but those houses, six in number, which were supplied with water from their own private wells, and not from the public fountains, were entirely exempt. This remarkable difference naturally led to a suspicion that the public water supply was connected with the cause of the epidemic, although the apparently immaculate source of this supply seemed to negative any such suspicion. The water came from a spring situated at the foot of the adjacent Stockhalden ridge. It was there received in a tank lined with brickwork, and carefully protected from pollution; nevertheless, a careful investigation into the source of this spring placed beyond all doubt the origin of the infection. Ten years previously, it had been proved that direct water communication through the intervening mountain existed between the spring and a brook in the Fürlerthal flowing past the farmhouse in which the typhoid cases occurred. At that time there was spontaneously formed, by the giving way of the soil at a short distance below the farmhouse, and close to the brook, a hole about 8 feet deep and 3 feet in diameter, at the bottom of which a moderate stream of clear water was observed to be flowing. As an experiment, the whole of the brook water was now diverted into this hole, at the bottom of which it entirely disappeared, but in an hour or two the spring at Lausen, at that time nearly dry from a long drought, overflowed with an abundance of water, which was turbid at first, but afterwards clear, and this continued until the Fürler Brook was again confined to its bed. It was, however, afterwards noticed that whenever the meadows below this hole were irrigated with the water of the Fürler Brook, the volume of the Lausen water supply became greatly augmented a few hours afterwards. Now this irrigation, practised every year, was carried on in the summer of the epidemic from the middle to the end of July, the brook being polluted by the dejections of the typhoid patients, for it was in direct communication with the closets and dungheaps of the infected house, whilst all the chamber-slops were emptied directly into it, and the dirty linen of the patients washed in it. Soon after the irrigation had begun, the water supplied to Lausen was at first turbid, acquired an unpleasant taste, and increased in volume. About three weeks after the commencement of the irrigation, the sudden explosion of typhoid fever in Lausen occurred.

In his search after the cause of this outbreak, Dr. Hägler did not rest satisfied with the evidence just recorded, but supplemented it by the following ingenious and conclusive experiments:—The hole in the Fürlerthal, already mentioned, was reopened, and the brook again led into it. Three hours later, the fountains of Lausen delivered double their previous supply of water; 18 cwts. of common salt previously dissolved in water were now poured into the hole, and soon the water at Lausen exhibited a stronger chlorine reaction, gradually increasing until it became very strong, whilst the proportion of solid matter dissolved in the water augmented threefold. The passage of the Fürlerthal water to the fountains of the fever-stricken village was thus established beyond doubt, but another interesting question here presented itself: Did the water find its way through the Stockhalden by a natural open conduit, or was it filtered through the porous material of the old moraine? To decide this point, 2½ tons of flour were first carefully and uniformly diffused in water, and then thrown into the hole, but neither an increase in the solid constituents nor the slightest turbidity of the Lausen water was observed after this addition.

Thus the investigation of the typhoid epidemic at Lausen showed—

1. That the epidemic followed immediately after the use, for dietetic purposes, of water which had received the dejections of persons suffering from typhoid fever, and that it was confined to persons who drank the infected water.

2. That the water still retains its infective properties after a filtration, which is efficient enough to remove very minute starch granules, but not sufficient, at all times, to prevent the passage of visible suspended matter in a still more minute state of division.

3. That spring water which has been polluted with human excrements before its descent into the earth, and which is subject to visible turbidity, is not always safe for domestic use.

4. That water which is polluted with normal, as distinguished from infected, excrementitious matters of human origin, may be used for dietetic purposes with impunity.

Inasmuch, therefore, as no means are known of distinguishing between normal and infected excrements, and as excrementitious matters are liable to become infected constantly with typhoidal, and occasionally with cholera poison, it is not safe to consume water which is contaminated with human dejections. Further, as typhoidal poison is almost certainly organized and living, it is likely to resist oxidation much longer than the dead organic matters with which it is associated; and as this poison is not removed from water by natural filtration through nearly a mile of porous earth, it follows that the tracing of the previous history of potable water is of prime importance in water analysis.

The method of estimating and expressing in a concrete form the previous sewage or animal contamination of a sample of water, was fully described in the paper by Dr. Armstrong and myself already alluded to; and, as the result of long experience, I have very rarely found that this estimation casts any suspicion upon water of really good quality. Thus out of 195 samples of upland surface water which have been examined, there were only 20 which contained, in the form of nitrates, nitrites, and ammonia, more nitrogen than is present in these forms in rain water; and in each of the 20 cases the excess was very slight, and the water was not obtained from such a source as to preclude altogether animal pollution. Again, out of 21 samples of spring water from indisputably unpolluted sources, there were only two which contained in 100,000 parts more than ·032 part of nitrogen in the form of nitrates, nitrites, and ammonia. These were both taken from a very small spring known as St. Boniface's Wishing Well. The spring issues from the steep slope on the south side of St. Boniface Down, Ventnor,

* The discussion which took place on this paper has been in type for some months, but, as the rules of the Chemical Society forbid the publication of papers communicated to that body before they have appeared in the *Journal of the Chemical Society*, we have been obliged to defer our report.

* *Deutsche Vierteljahrsschrift für öffentliche Gesundheitspflege*, Bd. vi, s. 154, and 6th Report of the Commissioners appointed in 1868 to inquire into the best means of preventing the pollution of rivers, p. 468.

Isle of Wight, about 100 feet below the summit of the down. The first sample was taken on Nov. 16, 1872, when the spring was scarcely running two gallons per hour; 100,000 parts of this sample contained ·083 part of nitrogen in the form of nitrates, nitrites, and ammonia. The second sample was collected on March 8, 1873, when the issue of water was at least twenty-fold as great as on the former occasion. This sample contained ·061 part of nitrogen as nitrates, nitrites, and ammonia, in 100,000 parts of water. Several explanations of this abnormal excess of nitrogen in the forms just specified offer themselves. In the first place, the upper part of Boniface Down is occasionally pastured by sheep and cattle; secondly, chalk naturally contains fossil animal remains, in which all organic matter is probably not oxidized; and thirdly, the nitrogen compounds in the rain falling upon Boniface Down may undergo concentration, by the evaporation of a considerable proportion of the water from the spongy surface of the chalk. Considerable support is given to the last explanation by the fact, that the proportion of chlorine as chlorides (which are chiefly derived from sea spray), is very high—viz., 6·4 parts in 100,000 parts of water in the autumn, and 7·4 parts in the spring sample, whilst the proportion in springs at the base of the down and nearer the sea is only from 3 to 3·6 parts in 100,000 parts of water. In summer and autumn the deposit of sea spray would be small, and the evaporation great, whilst in winter and spring the deposition of sea spray would be copious, and the evaporation comparatively small. This would explain on the one hand the occurrence of a larger proportion of nitrates, and a somewhat smaller proportion of chlorides in the autumn sample, and on the other, the presence of a smaller proportion of nitrates, and a somewhat larger one of chlorides in the spring sample.

The occurrence of nitrates in minute quantity, in the earth of unmanured forest land, observed by M. Bousingault, was probably due to the evaporation of rain water from the surface of the soil, and the concentration of nitrates in the upper layers.

As the result of long experience in connexion with the occurrence of nitrates, nitrites, and ammonia in potable waters, I am of opinion that the presence of nitrogen in these forms in water, in quantity above that which can be derived from rain, is reasonably safe and trustworthy evidence of the previous pollution of that water by animal matters.

On the other hand, it must not be forgotten that the absence of nitrogen in these forms is not absolutely conclusive evidence of immunity from such pollution. There are several agencies at work by which this testimony, as to the amount of animal matter previously in the water, may be weakened or altogether destroyed. Thus we look in vain for the full evidence of previous animal pollution, in the effluent water from fields irrigated with sewage; because the growing plants have removed a considerable proportion of ammonia, nitrates, and nitrites, from the liquid as it flows amongst their rootlets. In like manner the aquatic vegetation of rivers, lakes, and reservoirs slowly removes these compounds from water, and to that extent destroys the evidence of anterior animal contamination. Nitrates and nitrites are also rapidly destroyed when the organic matter in the water containing them enters into putrefaction—a condition which often occurs in streams or reservoirs containing much polluting organic matter. It again not unfrequently takes place in water-bearing strata far removed from the surface, although the water in this case may contain but a comparatively small amount of organic matter; the latter, however, cut off from a supply of atmospheric oxygen—as in the chalk beneath the London clay for instance—accomplishes its oxidation at the expense of the nitrates or nitrites, and thus destroys them. Owing to this cause, the evidence of previous animal contamination is not met with in the water of some deep wells, in which it might otherwise be expected to occur.

The previous animal contamination of water, as deduced from chemical analysis, must, therefore, always be regarded as a minimum quantity; it does not denote the comparative freedom of different samples of water from anterior pollution, but whenever analysis shows this excess of nitrogen in the shape of nitrates, nitrites, and ammonia, the water stands convicted of previous contamination, at least to the extent so indicated.

The meaning of the expression "previous sewage or animal contamination" may easily be misconstrued, unless an explanation accompanies analytical reports upon waters exhibiting such contamination. I have, therefore, for many years past, sent a copy of the following explanation with every such report; and when the water contains actual sewage or animal contamination, the words printed in italics in the fifth paragraph are erased:—

"Drinking Water.

"*Previous Sewage or Animal Contamination.*

"There is reason to believe that the excrementitious matters which exist in sewage are often possessed of intensely infectious properties; and that sewage mixing with water, even in the minutest proportion, is likely, by such properties, to spread particular diseases among populations which drink the water.

"Thus is explained the peculiar power which impure waters have, on many occasions, been shown to exercise in promoting great epidemics of typhoid fever and cholera.

"The existence of an infectious property in water cannot be proved by chemical analysis, and is only learnt, too late, from the effects which the water produces on man. But though chemistry cannot prove any existing infectious property, it can prove, if existing, certain degrees of sewage contamination. And every sewage contamination which chemistry can trace ought, *primâ facie*, to be held to include the probability of infectious properties.

"Nearly the whole of the animal matter which gains access to drinking water consists of sewage—that is, solid and liquid excrements.

"The column headed 'Previous Sewage or Animal Contamination,' in the accompanying analytical table, expresses, in terms of average London sewage, the amount of animal matter with which 100,000 lbs. of each water was, at some time or other, contaminated. Thus, 100,000 lbs. of the water of

had been polluted with an amount of animal matter equal to that contained in lbs. of average London sewage. *So far as chemical analysis can show, the whole of this animal matter had been oxidized and converted into mineral and innocuous compounds at the time the analysis was made; there is, however, always a risk lest some portion (not detectable by chemical or microscopical analysis) of the noxious constituents of the original animal matters, should have escaped that decomposition which has resolved the remainder into innocuous mineral compounds. But* this evidence of previous contamination implies much more risk, when it occurs in water from rivers and shallow wells, than when it is met with in the water of deep wells or of deep-seated springs. In the case of river water there is great probability that the morbific matter, sometimes present in animal excreta, will be carried rapidly down the stream, escape decomposition, and produce disease in those persons who drink the water; as the organic matter of sewage undergoes decomposition very slowly, when it is present in running water. In the case of shallow-well water, the decomposition and oxidation of the organic matter are also liable to be incomplete during the rapid passage of polluted surface water into shallow wells. In the case of deep-well and spring water, however, if the proportion of previous contamination do not exceed 10,000 parts in 100,000 parts of water, this risk is very inconsiderable, and may be regarded as *nil*, if the direct access of water from the upper strata be rigidly excluded; because the excessive filtration to which such water has been subjected, in passing downwards through so great a thickness of soil or rock, and the rapid oxidation of the organic matters contained in water when the latter percolates through a porous and aërated soil, afford a considerable guarantee that all noxious constituents have been removed.

"It follows from what has been already stated, that chemical analysis cannot discover the noxious ingredient or ingredients in water polluted by infected sewage or animal excreta; and as it cannot thus distinguish between infected and non-infected sewage, the only perfectly safe course is to avoid altogether the use, for domestic purposes, of water which has been polluted with excrementitious matters.

"This is the more to be desired, because there is no practicable process known whereby water, once contaminated by infected sewage, can be so purified as to render its domestic use entirely free from risk.

"Nevertheless, as it is very difficult in some localities to obtain water which has not been more or less polluted by excrementitious matters, it is desirable to divide such previously contaminated drinking waters into three classes—viz.:

1. Reasonably safe water.
2. Suspicious or doubtful water.
3. Dangerous water.

"*Reasonably Safe Water.*—Water, although it exhibits previous sewage or animal contamination, may be regarded as reasonably safe when it is derived either from deep wells (say, 100 feet deep), or from deep-seated springs; provided that surface water be rigidly excluded from the well or spring, and that the proportion of previous contamination do not exceed 10,000 parts in 100,000 parts of water.

"*Suspicious or Doubtful Water* is first shallow-well, river, or flowing water, which exhibits any proportion, however small, of previous sewage or animal contamination; and second, deep well or spring water, containing from 10,000 to 20,000 parts of previous contamination in 100,000 parts of water.

"*Dangerous Water* is, first, shallow-well, river, or flowing water which exhibits more than 20,000 parts of previous animal contamination in 100,000; second, shallow-well, river, or flowing water containing less than 20,000 parts of previous contamination in 100,000 parts, but which is known, from an actual inspection of the well, river, or stream, to receive sewage, either discharged into it directly, or mingling with it as surface drainage; third, as the risk attending the use of all previously contaminated water increases in direct proportion to the amount of such contamination, deep-well or deep-seated spring water exhibiting more than 20,000 parts of previous contamination in 100,000 must be regarded as dangerous.

"River or running water should only be placed in the second class provisionally pending an inspection of the banks of the river and tributaries; which inspection will obviously transfer it either to the class of reasonably safe water, if the previous contamination be derived exclusively from spring water, or to the class of dangerous water, if any part of the previous contamination be traced to the direct admission of sewage or excrementitious matters."

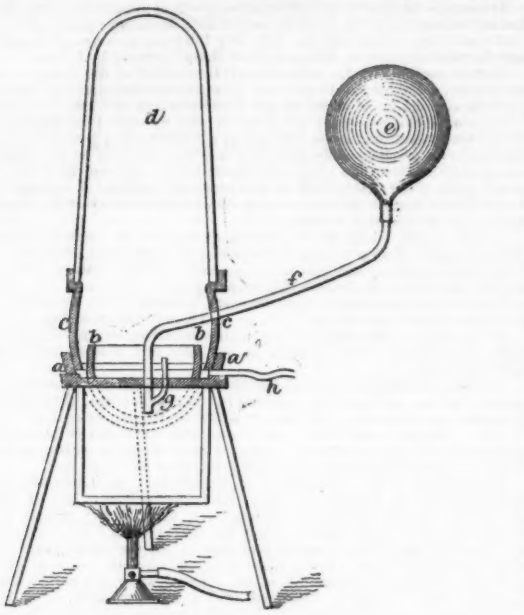
The actual, or present, as distinguished from the past polluting organic matter of potable water, can only be estimated from the amount of carbon and nitrogen found as constituents of the organic matter present in the water when the analysis is made. The mode of determining this organic carbon and nitrogen has been already fully described by Dr. Armstrong and myself. We have shown that by measuring these elements as carbonic anhydride and nitrogen gases one-millionth of a gramme of nitrogen and half a millionth of a gramme of carbon are distinctly measurable quantities. We also tested the method, by adding weighed quantities of various organic matters to known volumes of pure water and submitting these artificially prepared waters to analysis.

In ten such determinations of organic carbon, the errors never reached one-sixth of the total amount of carbon present, and averaged only one twenty-second. Errors of this magnitude, although they would be fatal in the determination of a complex molecular formula, have scarcely any appreciable effect upon the judgment of an analyst respecting the quality of a sample of water. Six determinations of organic nitrogen were similarly made. One of these was bad, the error amounting to one-fourth of the amount of organic nitrogen present, but the maximum error in the remaining five was only one-seventeenth, and the average was less than one-fiftieth. These errors, like those made in the case of organic carbon, would have no appreciable import in judging of the quality of a sample of potable water.

It is therefore evident that this method of determining organic carbon and nitrogen, as described in your journal eight years ago, was fully equal in delicacy and certainty to all the requirements of water analysis; but, as was then pointed out, it needed considerable care on the part of the operator, and it was necessary to conduct the evaporation of the water under discs of filter-paper, in an atmosphere kept as free as possible from ammonia—precautions which required the use of a room from which most of the ordinary laboratory operations were excluded. These inconvenient restrictions have long since been removed, and every part of a water analysis can now be performed with certainty and success in any laboratory fitted for the ordinary determinations of quantitative analysis; and I have here to express my thanks to Mr. W. Thorp, late chief assistant in the Rivers Commission laboratory, for the important and conscientious aid which he, for many years, afforded me in the progressive improvement of this process. Moreover, the time required for evaporation has been reduced by two-thirds, or even more, by the adoption of a simple contrivance devised by Professor Bischof and the risk of contamination during evaporation has been entirely obviated by a method devised by me for distilling off the water from the residue in a confined portion of air. These improvements have also secured greater accuracy in the determinations, and, without gross carelessness, errors of the magnitude just mentioned cannot now occur. Instead, however, of mentioning each improvement which has been effected, it will be preferable to describe the whole process of determining organic carbon and nitrogen. Pour one litre* of the sample of water into a suitable flask; add 15 cubic centimètres of a saturated solution of sulphurous acid in pure water, and boil the mixture briskly for a few seconds, in order to decompose the carbonates present. The sulphurous anhydride, which is used for the preparation of the solution of sulphurous acid, must be made from copper clippings and pure sulphuric acid, in order that it may be free from nitrogenous compounds. Evaporate the acidulated and boiled water to dryness in a hemispherical glass dish about one decimètre in diameter, placed in a copper capsule surrounded by a loose flanched cylinder of copper, which carries a glass shade about 12 inches high, and of suitable diameter. The capsule is heated by a water bath as shown in the annexed drawing:—*a a* is the copper capsule in which the glass dish, *b b*, is heated, *c c*, is the copper ring or cylinder, 80 millimètres high; it is provided at its upper edge with a rim or flanch of the same diameter as that of the copper capsule, so that the glass shade, *d*, may rest on either. The water to be evaporated is conducted from the flask in which it was boiled, to the glass evaporating dish by a self-supplying apparatus, *e*, *f*, *g*. The neck of the flask, *e*, is ground so accurately into the enlarged end of the glass tube, *f*, of about 8 millimètres internal diameter, as to be water-tight without the use of grease. The tube close to the enlarged end is bent at an angle of about 120°. The other end of the tube, which is formed into the usual self-supplying apparatus, *g*, is again bent so as to be parallel with the enlarged end of the tube. The acidulated water having been boiled in the flask and allowed to cool somewhat, the tube is attached, the apparatus inverted, and introduced through a slit in the upper edge of the copper cylinder into the glass dish, without, however, touching the bottom. The slit should be so deep that the shade does not quite touch the glass tube. When the flask is nearly empty, the copper cylinder and self-supplying apparatus may be removed, the remainder of the water poured into the dish, and the glass

* In the case of waters much contaminated by organic matter, half, or even a fourth of a litre is sufficient.

shade placed directly on the copper capsule. To ensure the destruction of nitrates, add one drop of a concentrated solution of ferric chloride to the first dishful. The condensed water, which trickles from the glass shade, collects in the space



between the glass dish and the copper capsule, and then flows off through the syphon tube, A. In this way the evaporation of a litre of water occupies from 24 to 26 hours; that is to say, with a constant gas-flame and self-supplying water-bath, if the evaporation be commenced in the forenoon, the residue can be burnt in the afternoon of the following day. If the water contains very large quantities of nitrates or nitrites, their reduction and the dissipation of their nitrogen requires the use of a larger quantity of sulphurous acid than that just mentioned; thus, when the nitrogen as nitrates and nitrites exceeds 0·5 part in 100,000 parts of water, the glass dish, containing the solid residue left on evaporation, must be filled with pure water containing one-tenth of its volume of a saturated solution of sulphurous acid, and the evaporation again carried to dryness; if it exceeds one part, a quarter of a litre of this solution should be evaporated on the residue; two parts, half a litre; and if five parts of oxidized nitrogen be present, one litre. In the ordinary course of analysis, the nitrogen as nitrates and nitrites will have been determined before the evaporation of the litre of water is finished.

The next operation is the combustion of the organic matter in the solid residue left on evaporation. This must be performed in a tube of the hardest Bohemian glass, and preferably of rather smaller diameter than that usually employed in organic analysis. A piece of this tube about 18 inches long is to be carefully washed, rinsed with distilled water, dried in an oven, and one end closed before the blow-pipe. The oxygen is supplied by granulated cupric oxide, which must be made by roasting thin sheet copper, or preferably oxidized copper (procurable from the sulphate of copper manufacturers), in a muffle or inclined iron tube.* Cupric oxide made from the nitrate is entirely useless for this process. Place the glass dish containing the dry residue upon a sheet of glazed paper, then add to the contents of the dish a few grammes of powdered cupric oxide, and with a small elastic steel spatula carefully remove the residue from the sides, and mix it intimately with the cupric oxide. Now put into the combustion tube about 1 inch of the granulated cupric oxide, and transfer, in the usual manner, the contents of the glass dish to the tube, rinsing out the former twice with small quantities of powdered cupric oxide, and transferring the rinsings to the tube. Fill up to a distance of 10 inches from the closed end of the tube with granulated cupric oxide, then put in a cylinder of fine copper gauze 3 inches long, made by rolling the gauze round a copper wire. This cylinder must, before use, be first oxidized in air and reduced in hydrogen as usual. In front of the gauze put about 1 inch of granulated cupric oxide. This last is required to oxidize traces of carbonic oxide, always formed by the reducing action of impurities in the copper gauze.

The open end of the tube must now be drawn out, so as to contract it to one-fifth of an inch in diameter for about 4 inches of its length, and the tube is then ready to be placed in the combustion furnace, and attached to the Sprengel pump by a caoutchouc and glycerine joint. After the furnace around the front end of the combustion tube is lighted, the pump is to be worked until the tube is exhausted as completely as possible, an operation which requires from five to ten minutes. The flow of mercury is then stopped.

The inverted tube filled with mercury destined to receive the gaseous products of combustion, having been placed over the recurved delivery end of the pump, the combustion is to be conducted in the usual manner, care being taken that, when the organic matter begins to burn, the operation proceeds very slowly, until the vacuum becomes considerably impaired. A combustion usually lasts from three-quarters of an hour to an hour: at its conclusion, unless the water residue contained much organic matter, no gas will have passed into the inverted tube. The pump must then be again set to work, and in from five to ten minutes the whole of the gases will be transferred to the inverted tube.

The gas collected consists of carbonic anhydride, nitric oxide, and nitrogen, which can readily be separated and determined by the ordinary processes of gas analysis, as described in the *Journal of the Chemical Society*, vol. xxi., p. 109. From the quantity of nitrogen thus obtained there has to be deducted the amount of ammoniacal nitrogen present in the water, or rather this amount *minus* the loss incurred by the dissipation of ammonia during the evaporation of the water. Potable waters rarely contain so much as ·01 part of ammonia in 100,000 parts, and then the loss of ammoniacal nitrogen during evaporation is too insignificant to require correction. Very impure waters, and certain deep well waters, however, sometimes contain much larger proportions of ammonia, and then the loss on evaporation with sulphurous acid becomes very considerable, as is seen from the following table, which embodies the results of numerous experiments made with artificial waters containing known quantities of ammonia:—

Parts in 100,000. Loss of Nitrogen by Evaporation of NH_3 [$SOHo_2$].

NH_3.	Loss of N.	NH_3.	Loss of N.	NH_3.	Loss of N.	NH_3.	Loss of N.	NH_3.	Loss of N.	NH_3.	Loss of N.
6·0	1·727	4·8	1·451	3·6	·977	2·4	·503	1·2	·250	·09	·014
5·9	1·707	4·7	1·411	3·5	·937	2·3	·463	1·1	·238	·08	·013
5·8	1·688	4·6	1·372	3·4	·898	2·2	·424	1·0	·226	·07	·012
5·7	1·668	4·5	1·332	3·3	·858	2·1	·384	·9	·196	·06	·010
5·6	1·648	4·4	1·293	3·2	·819	2·0	·345	·8	·166	·05	·009
5·5	1·628	4·3	1·253	3·1	·779	1·9	·333	·7	·136	·04	·007
5·4	1·609	4·2	1·214	3·0	·740	1·8	·321	·6	·106	·03	·006
5·3	1·589	4·1	1·174	2·9	·700	1·7	·309	·5	·077	·02	·004
5·2	1·569	4·0	1·135	2·8	·661	1·6	·297	·4	·062	·01	·003
5·1	1·549	3·9	1·095	2·7	·621	1·5	·285	·3	·047	·009	·001
5·0	1·530	3·8	1·056	2·6	·582	1·4	·274	·2	·032	..	..
4·9	1·490	3·7	1·016	2·5	·542	1·3	·262	·1	·017	..	..

It is, of course, undesirable to apply such large corrections for loss of ammoniacal nitrogen; and I have, therefore, endeavoured to replace the sulphurous by some other acid, whose ammonia salt shall either suffer less loss of ammonia, or shall be broken up on evaporation with total loss of ammonia. As the result of many trials, all salts of ammonia suffer volatilization or decomposition during the evaporation of their solutions; but of all salts tried, ammonic phosphate allows least ammonia to escape, and therefore in the analysis of sewage, or very impure waters, the slight acidification of the water ought to be effected with phosphoric instead of sulphurous acid. As this substitution is inadmissible where nitrates or nitrites are present in appreciable quantity, it is fortunate that sewage and other highly polluted liquids rarely contain these salts.

The ammonia in strongly ammoniacal waters may be entirely dissipated during evaporation by substituting boracic acid or borax for sulphurous acid; but the simultaneous carbon determination must be rejected, as boracic acid does not completely decompose carbonates. A separate carbon determination, with sulphurous acid as the acidifying agent, is therefore necessary. The use of borax is recommended when great accuracy is required in the determination of organic nitrogen in strongly ammoniacal waters.

The following table, constructed from numerous experiments with artificial waters containing known weights of ammonia, gives the correction for loss of ammoniacal nitrogen when the water is acidified with phosphoric acid:—

Loss of Nitrogen by Evaporation of NH_3 [PO_4Ho].

Volume Evaporated.	NH_3 per 100,000.	Loss of N. per 100,000.	Volume Evaporated.	NH_3 per 100,000.	Loss of N. per 100,000.	Volume Evaporated.	NH_3 per 100,000.	Loss of N. per 100,000.	Volume Evaporated.	NH_3 per 100,000.	Loss of N. per 100,000.
c.c.			c.c.			c.c.			c.c.		
100	10·0	·483	100	7·2	·386	100	4·4	·283	100	1·6	·143
..	9·9	·480	..	7·1	·382	..	4·3	·279	..	1·5	·137
..	9·8	·476	..	7·0	·379	..	4·2	·275	..	1·4	·132
..	9·7	·473	..	6·9	·375	..	4·1	·271	..	1·3	·127
..	9·6	·469	..	6·8	·372	..	4·0	·267	..	1·2	·122
..	9·5	·466	..	6·7	·368	..	3·9	·262	..	1·1	·117
..	9·4	462	..	6·6	·365	..	3·8	257	..	1·0	·112
..	9·3	·459	..	6·5	·361	..	3·7	·252	250	0·9	·096
..	9·2	·455	..	6·4	·358	..	3·6	·247	..	0·8	·080
..	9·1	·452	..	6·3	·354	..	3·5	·242	..	0·7	·070
..	9·0	·448	..	6·2	·351	..	3·4	·236	..	0·6	·060
..	8·9	·445	..	6·1	·348	..	3·3	·231	500	0·5	·050
..	8·8	·441	..	6·0	·345	..	3·2	·226	..	0 4	·040
..	8·7	·438	..	5·9	·341	..	3·1	·221	..	0·3	·030
..	8·6	·434	..	5·8	·337	..	3·0	·216	1000	0·2	·026
..	8·5	·431	..	5·7	·333	..	2·9	·211	..	0·1	·010
..	8·4	·428	..	5·6	·330	..	2·8	·205	..	0·09	·009
..	8·3	·424	..	5·5	·326	..	2·7	·200	..	0·08	·008
..	8·2	·421	..	5·4	·322	..	2·6	·195	..	0·07	·007
..	8·1	·417	..	5·3	·318	..	2·5	·190	..	0·06	·006
..	8·0	·414	..	5·2	·314	..	2·4	·184	..	0·05	·005
..	7·9	·410	..	5·1	31[illegible]	..	2·3	·179	..	0·04	·004
..	7·8	·407	..	5·0	30[illegible]	..	2·2	·174	..	0·03	·003
..	7·7	·403	..	4·9	30[illegible]	..	2·1	·169	..	0·02	·002
..	7·6	·400	..	4·8	·298	..	2·0	·164	..	0·01	·001
..	7·5	·396	..	4·7	·294	..	1·9	·158	..	..	..
..	7·4	·393	..	4·6	·291	..	1·8	·153	..	..	..
..	7·3	·389	..	4·5	·287	..	1·7	·148	..	..	..

The appropriate deduction for ammoniacal nitrogen having been made from the total nitogren obtained by combustion, the remaining weights of carbon and nitrogen still require correction for minute quantities of these elements adventitiously introduced during the analysis. It is desirable that each analyst should make several blank experiments, to determine these coefficients of correction; evaporating a litre of pure water with the usual quantities of sulphurous acid and ferric chloride, adding 0·1 gramme of freshly-ignited sodic chloride to form a tangible residue. The residue must be burnt and analyzed in the usual way. As the result of numerous fairly concordant experiments made in my laboratory, the adventitious C and N introduced into the analytical results, obtained from one litre of water, are 0·00005 gramme of C and 0·00005 gramme of N. *(To be continued.)*

IRON AND COAL TRADES OF SHEFFIELD, SOUTH YORKSHIRE, AND NORTH DERBYSHIRE.

(FROM OUR OWN CORRESPONDENT.)

The iron trade of this town and the surrounding districts, in common with the remainder of the country, appears to be growing worse than it has ever yet been, and it is not possible to say when there is likely to be an alteration for the better. Pig iron is cheaper, some of the hematite brands having fallen as much as 10s. per ton during the past ten days, and is hardly likely to recover unless the large speculative and stocking purchases, which are being indulged in by some of the leading houses, send up figures again. There is now so much pig iron on hand in all parts of the country that buyers have matters to a great extent in their own hands, except that there is nothing at present which requires them to operate on a large scale.

Merchant iron is wholly neglected, and the agents of the local producers of this class of iron are in despair. They aver that they are not selling sufficient to pay expenses, and some of them rather seriously contemplate closing their places of business. Common bars are still to be had at £7 5s. to £7 12s. 6d.; ordinary good, £8 5s. to £8 10s.; and medium, £8 10s. to £9.

The coal trade is growing slacker week by week, and it is very probable that many collieries will be closed during the ensuing few months. One of the pits of the West Staveley Colliery Company has been closed this week, and another near Sheffield is almost at a standstill. All the Derbyshire pits are working on an exceedingly limited scale, and in Yorkshire the competition is most keen. Prices are, in consequence, being cut very fine.

* Before use, a sample of this cupric oxide should be assayed in a blank combustion. It should yield on a very minute bubble of gas, which ought to be almost entirely absorbed by potassic hydrate.

IRON AND COAL TRADES OF SOUTH STAFFORDSHIRE AND EAST WORCESTERSHIRE.

(FROM OUR OWN CORRESPONDENT.)

There is no alteration in the condition of the iron trade here since last report; buyers appear to be holding back all specifications until the result of the forthcoming quarterly meeting of the trade is made known. The market was this week well attended, and though numerous inquiries were made, very few transactions were reported. Some of the merchants profess to expect a reduction in prices, but unless some relief is experienced by a fall in the quotations for coal, it is impossible that the current rates for iron can be lowered, but the efforts of the coal-owners to obtain any concession from the miners in respect to the proposed increase in the working hours have so far been strenuously opposed by the men, and denounced by their leaders, and they are strengthened in the position they have taken by the reports which reach them from other mining districts. A request from the Miners Association of Warwickshire has also been received, urging the men to resist the proposed encroachment on their working time, believing that eight hours labour in mines is quite sufficient under any circumstances. Meanwhile the men are suffering great distress, and the poverty-stricken aspect of most of the mining villages is lamentable. Few of the pits are working more than half time, and the amount of employment is now materially diminished by the flooding of the mines in the Bilston district, consequent upon the stoppage of the pumping-engines.

Prices for the most part are unchanged both in respect of coal and iron. Common cinder pig iron is perhaps a shade easier, owing to the increased competition on the part of smelters in the Cleveland district, but the better qualities of both raw and finished iron are firm at late rates. The quarterly meeting of the iron and coal trades will be held at the Birmingham Exchange on Thursday next.

THE LANCASHIRE COAL AND IRON TRADES.

(FROM OUR OWN CORRESPONDENT.)

There have been a few settlements of gas coal contracts during the past week or so, and one or two of the colliery firms, more fortunate than others, have succeeded in placing pretty nearly the whole of their available get, but I still hear a great many complaints as to the difficulty experienced in securing contracts, and there are, no doubt, a considerable number of buyers who have not yet covered their requirements for the ensuing season. The average prices at which business appears to have been done are about 8s. 6d. per ton for common, and 9s. to 10s. per ton for good Wigan screened gas coal at the pit mouth.

In other descriptions of coal the market continues very flat, and, as I anticipated in previous reports, there is a gradual easing down of prices, without, however, any formal alteration of the list quotations. In order to get rid of their superabundant supplies of round coal, colliery proprietors are in some cases offering inducements to merchants to take in their winter stocks, and there has been a slight giving way in the higher quotations at the pits in the Wigan districts, Arley Mine coal, which was ruling as high as 12s. per ton, being in many cases now quoted not above 11s. 6d. per ton, and Pemberton four-feet 9s. to 9s. 6d. per ton, whilst good orders for common coal, suitable for forge purposes, could be placed at less than 7s. per ton at the pit mouth. Burgy and slack, although the production is not large, are also not so firm, owing to the short time now being worked at many of the mills, and quotations range about 3s. 6d. to 4s. per ton for slack, and 5s. 6d. to 6s. per ton for burgy at the pit mouth.

The reduction of 15 per cent. in South-West Lancashire is meeting with temporary opposition on the part of some of the men; the notices expired last week, and work was stopped at many of the pits, as the men had received no reply from the masters with regard to a proposal that the matter should be submitted to a Board of Conciliation. In the Skelmersdale district, however, the men have accepted the reduction, and there is no doubt that the others will follow before long, as there is no probability of the masters giving way.

There is little or no change to notice in the iron trade of this district. Makers, who do not seem disposed to give way any further, quote late rates, which are nominally the same as last week, but merchants continue to undersell in the market in order to realize on their deliveries. Makers quotations are about as under:—No. 3 Lancashire foundry pig iron, delivered into the Manchester district, 57s. 6d.; No. 4 forge, 56s. 6d. per ton; No. 3 Middlesbrough foundry, 54s. 3d. to 54s. 9d.; No. 4 foundry, 53s. 3d.; and No. 4 forge, 51s. 9d. to 52s. 3d. per ton. In finished iron some of the local makers would be willing to accept good specifications of bars at £7 per ton delivered.

THE COAL AND GENERAL TRADE OF THE NORTH OF ENGLAND.

(FROM OUR OWN CORRESPONDENT.)

The coal trade of the North of England is a trifle firmer than it has been. All round, something like an improvement of from 3d. to 6d. per ton may be noted. But the price of the second-class qualities of gas coals is very low. Steam coals are in very good demand for most parts of the world. Last week a large quantity of gas coals was shipped from Tyne Dock by steamer, and, from the excellent supply of tonnage there is in the Tyne, there is likely to be a good deal of activity in that direction for some time. Manufacturing coals, which depend upon local demand, are quoted at a ruinously low price. Any quantity of small coals might be had in Northumberland at the pits as low as 2s. per ton. A good deal of manufacturing and small coals has been stocked at the pits for want of a market. The price of gas coals has a very wide range. They are sold at quotations from 6s. up to 8s. 6d. per ton. Steam coals range from 9s. 6d. to 12s. 6d. per ton, but the principal business that is being transacted is for a quality ranging from 11s. to 11s. 6d. per ton. The collieries are now working very steadily, and the steam collieries are, as a rule, making ten days per fortnight, which is full time.

The coasting business is very poor. Gas coals are carried to London by steamers at from 4s. 3d. to 4s. 6d. per ton; Havre, 6s. 3d.; Rouen or France, 7s. 6d. per ton; with the English bye-ports in proportion. There is a good deal of small coasting sailing tonnage lying in the Tyne and adjacent rivers without employment. The fighting which is going on in the East is producing a depressing effect upon the outward shipping trade thence; but business is a little better to the Baltic and some of the Italian ports. It is poor to Turkey and the Black Sea generally. On the whole, it is thought that there will not be any great rise in the value of freights for some time.

In the Cleveland iron district pig iron keeps well up, both as regards the extent of its production and consumption, and most makers are pretty firm in their rates, preferring to hold their iron than dispose of it at figures materially below present quotations. There is an active continental trade. The price of railway rails and other manufactured iron is nominally about the same, and the manufacturing iron trade may be described as dull.

The chemical and manufacturing trades of the Tyne were a little more active last week.

TRADE NOTES FROM SCOTLAND.

(FROM OUR OWN CORRESPONDENT.)

As I have got a rather extraordinary budget of gas news to report this week, I shall be under the necessity of summarizing it, in order to indicate the facts that are at my disposal. It may be worth while, perhaps, to take the facts in the order suggested by the alphabetical arrangement of the names of the places to which they refer:—

Airdrie.—The price of gas in Airdrie is to be reduced to 4s. 2d. per 1000 feet on all accounts dating from the 1st current.

Alyth.—At the annual meeting held last week, report showed balance of £412 after paying working expenses. Dividend of 8 per cent. declared, which absorbed £200, leaving balance of £212. Price of gas reduced from 8s. 4d. to 7s. 6d. per 1000 feet.

Arbroath.—Annual balance-sheet shows profit of about £500, compared with a loss on the working of the previous year of £628 4s., being equal to about 10d. per 1000 cubic feet. Coals used for fuel only 180 tons, as compared with 474 tons, and the result per ton of coal carbonized being increased by 89⅝ feet.

Auchtermuchty.—At the annual general meeting of the gaslight company, held lately, a dividend of 10 per cent. was unanimously declared, and price of gas reduced from 7s. 1d. to 6s. 3d. per 1000 cubic feet, and £60 to the good.

Brechin.—Dividend of 11 per cent. on paid-up capital declared to exhaust £297. On recommendation of directors at annual meeting just held, price of gas reduced to 5s. per 1000 cubic feet., and meeting resolved, by 127 votes against 34, to allow no discounts. Some conversation took place on the recent doubling of the value of the shares, and on the proposed purchase of the works by the Police Commission, a committee being appointed to confer with committee of Police Commission on the matter.

Coupar Angus.—Last year's income, as reported at annual meeting, only showed a profit of 5½ per cent., but dividend of 7½ per cent. declared, difference being made up out of sinking-fund of company. Price of gas reduced to 8s. 4d., or 10d. per 1000 cubic feet less than in past year.

Crieff.—On recommendation of directors, dividend of 10 per cent. declared, and price of gas reduced from 7s. 6d. to 7s. 1d. per 1000 cubic feet.

Dalry.—At meeting of directors of Dalry Gas Company, last Friday evening, price of gas reduced from 5s. to 4s. 7d. per 1000 feet, reduction to count from last May term.

Dundee.—Monthly meeting of Gas Commission held last Wednesday. Gas-rental collected during May £3007 17s. 8d., and during June £453 3s. 8d. Property purchased at expenditure of £1035 3s. 9d. for extension of works at Lochee. Manager instructed to prepare general report and estimate of probable extensions and requirements of works during next seven years, in view of it being considered necessary to apply to Parliament for a new Act.

Dunfermline.—Annual meeting of shareholders of Dunfermline Gaslight Company held on Wednesday week. Past financial year one of great prosperity, consumption of gas increasing more than in any former year, and additional manufacture accomplished by the existing plant and apparatus. Contracts for next season's cannel coal entered into upon somewhat lower terms than those of last year. Price of gas reduced last year, and to be still further reduced. Works and mains in good and efficient order, and maintained in best possible state of repair. Dividend of 31s. 6d. per share, or 9 per cent., recommended by directors, and unanimously agreed to. Manager (Mr. M'Kenzie) highly complimented upon the zealous and efficient manner of discharging his duties.

Dysart.—Meeting of shareholders of Dysart Gaslight Company held last week, and dividend of 7½ per cent. declared, and price of gas reduced to 6s. 8d. per 1000 feet.

Elgin.—Price of gas reduced 10d. per 1000 cubic feet.

Forfar.—Annual accounts not yet audited, but they are reported to show most favourable results. Coal contracted for at 20s. 5d. per ton, as against 26s. last year. Expenditure of past year, £5250 15s. 8d., and revenue (including sales of gas and residuals, and rent of meters), £6272 10s., giving a surplus of £1021 14s. 4d.. Probable reduction in price of gas of at least 1s. 3d. per 1000 feet. From 21 retorts 160,000 cubic feet of gas produced in November, December, and January; and during past twelve months ten million cubic feet of gas produced. Gas Commissioners, by vote of 7 to 2, have resolved to erect four additional retorts.

Galashiels.—Forty-second annual meeting of shareholders of Galashiels Gas Company just held. Report of directors showed profit for last year to be £2179 5s. 5d., making with balance of £500 from last year a total of £2679 5s. 5d. Dividend declared at rate of 10 per cent., and 5 per cent. bonus, with £654 5s. 5d. carried forward to next account. Price of gas reduced from 4s. 7d. to 3s. 9d. per 1000 cubic feet, the illuminating quality being 29 candles.

Inverness.—At recent special meeting of Police Commissioners, some correspondence regarding coal contracts was read, as also a charge against Mr. Steven, manager of works. The latter indignantly threw back the insinuation, and tendered resignation of his appointment in the service of the commissioners, which was accepted.

Irvine.—At annual meeting of Irvine Gas Company just held, directors report was read, setting down expenditure of past year at £2369 3s. 4d., and revenue at £3684 15s. 5d. Dividend of 10 per cent. declared, or 20s. on original shares, and surplus (£2091 6s. 7d.) to be devoted to new extensions now being made to works. Price of gas reduced from 5s. 10d. to 5s. 5d. per 1000 cubic feet.

Kilmarnock.—Annual balance-sheet just issued, showing clear profit of £1153 4s. 10½d., subject to deduction of £460 10s. 6d. for the sinking-fund. Sale and manufacture increased by two million cubic feet, and price reduced last year 10d. per 1000 feet. Amount drawn from residual products works last year—£1066—largest in any one year. Illuminating power during past year averaged 28·5 candles. Mains to be extended further in Hurlford direction.

Kilwinning.—At annual meeting of gas company, held a few days ago, dividend of 10 per cent. declared, and price of gas reduced to 5s. 5d. per 1000 feet.

Leslie.—Sale of 121 original shares, of £1 each, of the Leslie Gaslight Company's stock took place last Tuesday. Bidding confined to consumers of gas made at company's works, and shares disposed of at 32s. 6d., 32s. 9d., and 33s. each.

Saltcoats.—Price just reduced from 5s. 10d. to 5s. per 1000 feet.

Strathmiglo.—Annual meeting held last Monday evening, and report of directors showed a very prosperous year. Dividend of 6 per cent. declared, price reduced to 6s. 8d. per 1000 cubic feet, and manager's salary increased.

Uddingston and Bothwell.—Dividend of 7½ per cent. declared at annual meeting of Uddingston and Bothwell Gas Company last Monday evening.

Last week's report upon the Glasgow gas shows the minimum illuminating power to have ranged from 25·50 candles at Dawsholm, to 29·01 candles at Tradeston station, the maximum being 28·28 at Dawsholm, 28·86 at Dalmarnock, 29·44 at Tradeston, and 30·90 at Partick. The Dalmarnock gas showed 11·70 grains of sulphur per 100 cubic feet, and 0·12 grains of ammonia.

Lower prices have been reached for pig iron warrants, the closing quotations on Friday being 56s. 6d. cash, and 56s. 7½d. one month open. Several makers have just reduced their quotations 6d. to 1s. per ton.

The state of the coal market shows no change, and unfortunately there is as yet no prospect of better trade. The shipping department seems to be almost at a standstill, orders being scarcely obtainable, and the local demand is very meagre.

STOKE AND FENTON GAS COMPANY.—At the half-yearly meeting, on the 7th inst., a dividend of 5 per cent. for the half year was declared.

SALE OF GAS SHARES AT DOVER.—Two hundred new £10 shares in the Dover Gaslight Company were submitted for public competition by auction on Thursday last. The competition was very spirited, each of the shares realizing the sum of £15.

LONGTON GAS-WORKS PURCHASE.—The directors of the Longton Gas-Works having received a deputation from the Town Council on the subject, have resolved to adjourn the consideration of the extension of time for the purchase of their undertaking until the meeting of shareholders in August.

SLAITHWAITE GAS COMPANY, LIMITED.—The annual meeting was held on the 5th inst.—Mr. C. Thornton in the chair. The company have a capital of £12,920; of this sum, £2920 is loan, and the rest share capital. After carrying £214 14s. to the reserve-fund, which now amounts to £642 11s. 7½d., a dividend of 5½ per cent. was declared on the trading account for the past year, and a bonus of 4½ on the profit on the sale of shares, which made the dividend into 10 per cent.

NEW COMPANIES.—*George Bower and Co.*—This company has been formed to take over the freehold works, property, and effects of the business of engineer and contractor for public works, for many years carried on by Mr. George Bower, at St. Neot's and West Hartlepool. It has been registered, with a capital of £100,000, in £10 shares.—*Tuscan Gas.*—With a capital of £25,000, in £10 shares, this company was registered on the 23rd ult., for carrying into effect an agreement of the 24th of May, between Thomas Strange, of Prato, Italy, and Arthur Frederick Phillips, having for its object the purchase by the company of a concession for lighting with gas the town of Prato, in Italy, and also the gas-works established thereunder. The purchase consideration is £18,000.

TAMWORTH GAS COMPANY.—The ordinary general meeting of shareholders was held on Tuesday, the 4th inst.—Mr. J. Hill presiding. The statement of accounts for the year ended Dec. 31, 1875, showed a total expenditure of £2602 4s. 8d., receipts (inclusive of balance from accounts ending Dec. 31, 1874, of £666 6s. 3d.), £3954 7s. 10d.; leaving a balance applicable to payment of dividends of £1352 3s. 2d. The chairman said no dividend would be declared that day. It would be necessary to obtain the money first (the balance-sheet showing the sum of £2736 12s. 3d. owing to the company for gas, coke, residual products, &c.), and the directors could then, at 14 days notice, call a meeting to declare a dividend. Some discussion ensued on one or two items in the accounts. The balance-sheet was adopted and the retiring director and auditor re-elected. Mr. Bull, the manager, was instructed to submit an estimate to the next meeting of the cost of laying down four-inch pipes from the commencement of Gungate to the workhouse.

BIRMINGHAM CORPORATION GAS SUPPLY.—At the meeting of the borough justices on the 4th inst., Mr. Jackson, the inspector appointed by the Gas Committee, made his report on the quality of the gas supplied by the corporation. He stated that on the 30th of May he visited the gas station at Saltley, and found the gas to be 17·93 candles; at Windsor Street it was 14·36 candles. On the following day, by permission of the ex-Mayor, he tested the gas at Fazeley Street and Adderley Street, and at the former found it 14·15 candles, and at the latter 14·34 candles. At the request of the Mayor, he subsequently went with Mr. Hunt, the engineer, to the three works to test the gas, and found it 14·84 candles at Adderley Street, 15·18 at Fazeley Street, and 13·65 at Windsor Street. As it did not fall within his duties to find out the cause of this low state of the gas, he simply intimated to the engineer that he thought lime should be used to remove the carbonic acid. He knew they had ceased to use lime in the purification, and the presence of 1 or 2 per cent. of this acid had a very deteriorating effect upon the value of the gas. However, lime was delivered at the three stations in less than 48 hours, and had been in continued use since; hence the improved quality of the gas in a great measure. The use of lime in the purification had not been discontinued at Saltley, and the gas there had been maintained at about 16 or 17 candles. On the 5th inst. he visited Saltley, and found the gas 18·20 candles, and at Windsor Street 16·82 candles on the same day. On making experiments with Mr. Hunt, at Moor Street, as to the light-giving power of the old and new burners, they found that whereas the old burners gave 16·28 candles for the gas then supplied, by the new burner the light was 17·78 candles—a difference of 1½ candles. From June 12 to 27 the testing at various places gave an average of 17·30 candles. Taking the averages, he considered the gas now quite as good as when it was supplied by the companies, and the instructions from the Gas Committee to the engineers were that at the works the gas must be made 17 candles. No doubt there would be unavoidable accidents at times to reduce its value somewhat, but if it was not lower than the standard of 15 candles there could be no just cause for complaint.

Register of New Patents.

APPLICATIONS FOR LETTERS PATENT.

2497.—TYLOR, A., Newgate Street, London, "Improvements in apparatus and arrangements for controlling, regulating, and arresting the supply of water for sanitary, domestic, and other uses, and preventing waste." June 16, 1876.
2501.—COLLS, F. W., Erith, Kent, "Improvements in the manufacture of gas for heating and lighting, and in the apparatus to be employed therein." June 16, 1876.
2506.—ANDERSON, W., Southwark Street, London, "Improvements in the construction of gas-furnaces." A communication. June 16, 1876.
2508.—M'MINNIES, J. G., Farington, Lancs, "Improvements in balls for what are commonly called ball taps or valves." June 16, 1876.
2513.—EWART, G., Euston Road, London, "Improvements in gas heating apparatus." June 17, 1876.
2526.—GOEDICKE, F. W. E. R., Stratford, London, "The effectual and profitable disposal of sewage without pollution of rivers and water-courses, and without any alteration of the usual water-closet and drainage system." June 19, 1876.
2527.—HAZLEHURST, G. S., Runcorn, Chester, "Improvements in and apparatus for pumping liquids and pumping and condensing gases, such apparatus being also applicable for use as a blowing or exhausting engine." June 19, 1876.
2550.—LAKE, W. R., Southampton Buildings, London, "Improvements in adjusting wrenches or spanners." A communication. June 20, 1876.
2556.—PARKER, T., Coalbrookdale, Salop, "Improvements in direct-acting steam-pumps and in steam-engines." June 20, 1876.
2558.—TONGUE, J. G., Southampton Buildings, London, "Improvements in apparatus for raising and forcing liquids." A communication. June 21, 1876.
2582.—HARRIS, I. B., Fountainbridge, Edinburgh, "Improvements in india-rubber valves, and in the means for retaining valves in their seats." June 22, 1876.
2583.—WILSON, R., and LEACH, W., Accrington, Lancs, "Improvements in ejectors or apparatus for raising and forcing liquids." June 23, 1876.
2591.—REDWOOD, T. B., North Finchley, London, "Improvements in the manufacture of gas for burning." June 23, 1876.
2635.—NEWTON, A. V., Chancery Lane, London, "Improvements in liquid-meters." A communication. June 26, 1876.
2637.—LAKE, W. R., Southampton Buildings, London, "Improvements in couplings or connexions for pipes, faucets, and the like." A communication. June 26, 1876.
2682.—SOMERVILLE, J., Edinburgh, "Improvements in the construction and special application of valves." June 29, 1876.
2684.—JOHNSON, J. H., Lincoln's Inn Fields, London, "Improvements in cocks." A communication. June 29, 1876.

PATENTS WHICH HAVE PASSED THE GREAT SEAL.

121.—MARCHANT, G. M., Huddersfield, "Improvements in steam and water taps or stop-cocks." Jan. 11, 1876.
181.—BOND, F. T., Gloucester, "Improvements in filtering and purifying water and other liquids, and in apparatus for that purpose." Jan. 18, 1876.
940.—BRAY, G., Leeds, "Improvements in gas-burners." March 4, 1876.
968.—SMITH, W., Kennington, London, "Improvements in dry gas-meters." March 6, 1876.
1355.—HILLE, F., Chiswick, London, "Improvements in treating sewage." March 29, 1876.
1466.—LAKE, W. R., Southampton Buildings, London, "Improvements in the manufacture and utilization of combustible gases, and in apparatus therefor." A communication. April 6, 1876.
1499.—LOUTTIT, K. M'L. P., Greenwich, London, "Improvements in the manufacture of gas for heating and lighting purposes." April 8, 1876.
1631.—LAIDLAW, D., Glasgow, "Improvements in lighting railway carriages, and in the mechanism or apparatus employed therefor, the same being applicable for lighting tramway cars, ships, factories, and other buildings." April 19, 1876.
1697.—PORTER, J. H., Lavenham, Suffolk, "Improvements in filtering water and in the apparatus employed therein." April 21, 1876.

PATENTS WHICH HAVE BECOME VOID

BY REASON OF THE NON-PAYMENT OF THE ADDITIONAL STAMP DUTY OF £50 BEFORE THE EXPIRATION OF THE THIRD YEAR.

1697.—HAZELTINE, G., "An improved method of and apparatus for lighting and extinguishing gas-burners." May 10, 1873.
1701.—MAGUIRE, W. R., "An improved water-filter." May 10, 1873.
1752.—POTEL, A. P., "Improved joints for water, gas, steam, and other pipes." May 14, 1873.
1794.—BOUSFIELD, G. T., "Improvements in motive-power engines to be worked by steam or other fluid, applicable also to meters and pumps." May 16, 1873.
1807.—TELLING, W. A., and JOHNSON, S., "Improvements in gas-meters." May 19, 1873.
1953.—ORSAT, L. H., "An improved apparatus for analyzing gas." May 22, 1873.
1887.—BOX, W. W., "Improvements in apparatus used in the manufacture of gas." May 26, 1873.
1894.—SPENCER, W. H., "Improvements in the process of and apparatus for manufacturing illuminating gas." May 26, 1873.
1915.—HOOD, W. C., "An improved meter for water and other liquids." May 28, 1873.
1917.—KIDD, J., "Improvements in air or vapour gas machines, and in apparatus connected therewith." May 28, 1873.

The GRAND MEDAL of MERIT at the VIENNA EXHIBITION has been AWARDED to

GWYNNE & BEALE'S PATENT IMPROVED GAS-EXHAUSTERS,

FIG. 224.

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GWYNNE & CO.

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Ever produced, and the most economical in working.

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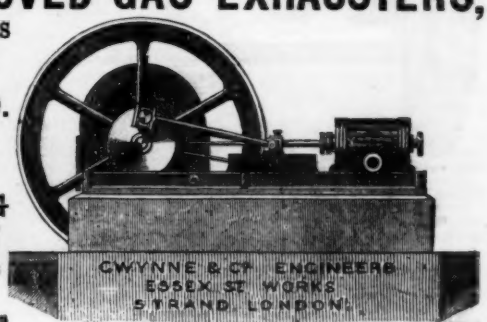

FIG. 225.

Fig. 224 represents one of those erected at the Imperial Gas-Works, Bromley, capable of passing 210,000 cubic feet of gas per hour. Several others of the same size are now on order for the same Company. These Patent Machines combine the highest quality of workmanship and materials, the largest bearings and wearing surfaces, with the **most perfect system of action yet discovered.** Fig. 225 represents one of a series of four at the Nottingham Gas-Works, each passing 52,500 cubic feet per hour. GWYNNE AND CO. *do not pretend to enter into a struggle with other makers in respect to cheapness. They have never sought to make price the chief consideration, but to produce Machinery of the very highest quality, and the most approved design and arrangement.* Their prices have been estimated with a due regard to the **excellence of the article produced,** and when this is taken into consideration, they have no fear for the result. The orders executed this season for Exhausters and alterations to their patented system amount to over 4,000,000 cubic feet of gas passed per hour, and to over 300 horse power for Engines to drive them. In every instance their work is giving the greatest satisfaction. Numerous testimonials and references can be given.

REGULATORS, BYE-PASSES, STOP-VALVES, GAS-VALVES, & MACHINERY FOR GAS MANUFACTURE, OF ALL SIZES,

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G. & Co. are now manufacturing for a London Gas Company three of their 210,000 *cubic feet Patent Gas Exhausters, and many of all sizes.*

NORTH BRITISH ASSOCIATION of GAS MANAGERS.

The FIFTEENTH ANNUAL GENERAL MEETING of the Members of this Association will be held in the ROYAL SCOTTISH SOCIETY OF ARTS HALL, **117, GEORGE STREET, EDINBURGH,** *On FRIDAY, July 14, 1876, at Half-past Ten* A.M.

SAMUEL STEWART, ESQ., PRESIDENT, *Will occupy the Chair.*

PROCEEDINGS.

BUSINESS MEETING.

Reading of Minutes.
Admission of New Members, &c.

PRESIDENT'S INAUGURAL ADDRESS.

Auditor's Report.
Election of Office-Bearers.

LIST OF PAPERS AND COMMUNICATIONS.

"Gas Governors, with Description of Peebles' Patent Governors for Stations, Districts, Dwelling-Houses, and Public Lamps." By Mr. D. BRUCE PEEBLES, of Edinburgh.

"A Ready Means of Adjusting the Seal on Dip-Pipes, and otherwise Reducing Pressure on Retorts." By Mr. WILLIAM KEY, of Glasgow.

"Sunday Labour in Gas-Works." By Mr. JAMES ALEXANDER, of Corstorphine.

"The Utilization for Illuminating Purposes of the Gases Resulting from the Destructive Distillation of Shale in the Manufacture of Paraffin Oil." By Mr. WILLIAM YOUNG, of Clippens, Paisley.

LECTURE.

At Three o'clock, a Lecture will be delivered by STEVENSON MACADAM, Ph.D., Lecturer on Chemistry, &c., Edinburgh, on "The Chemistry of the Combustion of Coal Gas."

DINNER.

At Half-past Four o'clock, the Members and Friends will Dine together in the Café Royal Hotel, West Register Street, Edinburgh. Tickets for the Dinner, 5s. each, may be had from the Secretary; early application for which is specially requested.

WM. M'KENZIE, Hon. Sec.

Gas-Works, Dunfermline, June 30, 1876.

ADVANTAGES OF GAS FOR

COOKING AND HEATING.

HINTS ON GAS BURNERS, &c.

By **MAGNUS OHREN, A.I.C.E., F.C.S.**

Specimen Copy by post Threepence, direct from MAGNUS OHREN, Gas-Works, Lower Sydenham, London, S.E.

WANTED, a second-hand Cast-Iron GASHOLDER-TANK, with or without columns and girders. Diameter 36 ft. 6 in. by 12 ft. deep.

Address, stating price, and where situated, to Mr. R. L. RENWICK, 16, Market Street, Hexham, NORTHUMBERLAND.

WANTED, a situation as Meter Fixer and Main and Service Layer. Can do repairs at works, and fitting if required.

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TO GASHOLDER MAKERS AND ERECTORS.

WANTED, good steady Men, accustomed to making and erecting gasholders.

Apply to W. C. HOLMES AND CO., Whitestone Iron-Works, HUDDERSFIELD.

WANTED, for a small town in Somerset, a MAN to take charge of a Gas-Work. Must be acquainted with fitting and service laying. Character required.

Apply to T. W. R. WHITE, Gas Engineer, SHERBORNE.

WANTED, by the Advertiser, a situation as METER-INSPECTOR, Fitter, Index Taker, Service Layer, &c. Town, country, or abroad. Good references.

Address H. E. FLAMBE, 2, Pembury Villas, Gladstone Road, SOUTH WIMBLEDON.

WANTED, at once, for a small Gas-Work in North Wales, a WORKING MANAGER, who understands the manufacture and distribution of gas, retort-setting, main-laying, &c. Salary to commence at £50 per annum. House, gas, and coal found.

Applications, stating experience and references, to be forwarded immediately to Mr. J. T. HALL, Prescot, LANCASHIRE.

WANTED immediately, by a Gas and Water Company (incorporated by Act of Parliament) supplying a fashionable watering-place in the South of England of about 6000 inhabitants, a SECRETARY and MANAGER, thoroughly conversant with the manufacture and distribution of gas, the supply of water, and book-keeping by double entry. A clerk and collector, and efficient foreman are kept.

Applications, stating age, salary required, when disengaged, &c., with testimonials (copies only) to be forwarded to the undersigned before the 21st of July inst., marked "Vectis."

GEORGE GARNETT.

The Friars, Ryde, Isle of Wight, July 10, 1876.

TO GAS MANAGERS.

A Young Mechanic will give £25 pre- mium for employment in any Gas-Work, either as CLERK or WORKMAN. Highest references.

Address A. L., 41, Thomas Street, WOOLWICH.

THE Advertiser (a retired Gas Engineer(requires some one who is a large consumer or purchaser of Fire-Clay Goods, to join him in purchasing and developing a FIRE-BRICK WORKS, offered him under exceptional circumstances.

The clay is of first-rate quality, and the works, having a siding from a railway, and being near a port, are well suited for a large and profitable business. Capital required £750 to £1500.

Address No. 280, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

FOR SALE—Two 6 ft. by 5 ft. 6 in. PURIFIERS, with 5-in. connexions complete.

Apply to SECRETARY, Gas-Works, Whitchurch, SALOP.

FOR SALE—Station-Meter by Brad- dock, in perfect order, new five years ago, to pass 6000 feet per hour; 7-in. connexions. Also four PURIFIERS, 6 ft. square, hydraulic centre-valve, 7-in. connexions.

Apply to W. GUNDILL, Gas-Works, PONTEFRACT.

GAS STOCK TO BE SOLD, in a country Gas-Work, incorporated by Act of Parliament.

Apply to W. L. RAMSDEN, 11, Fitzwilliam Street, HUDDERSFIELD.

ON SALE—One Round Station-Meter, to pass 12,000 feet per hour, with 8-in hydraulic valves and bye-pass. Will be thoroughly overhauled and fitted with new drum.

Apply to J. AND J. BRADDOCK, Globe Meter-Works, OLDHAM.

GASHOLDER COLUMNS FOR SALE, cheap and good, twelve in number, about 30 ft. high, diameter near base 2 ft., near cap 1 ft. 6 in., with moulded caps and bases, guide-rails, and brackets complete, and suitable for a gasholder about 90 ft. diameter by 30 ft. deep.

Offers for same, delivered at a railway station in Lancashire, to be addressed to No. 279, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

BRITISH ASSOCIATION OF GAS MANAGERS.

VISIT TO BECKTON, JUNE 15, 1876.

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Stamps or Post-Office Orders to

F. WELLS, BARKING, ESSEX.

THE GAS TRADE CIRCULAR AND REVIEW will be issued (a Second Edition) on the 16th of July, this having been found necessary owing to much valuable matter coming in at the last moment.

Price 3d., by post 3½d., or may be had everywhere at the Book and Paper Stalls of Messrs. W. H. Smith and Sons; or by applying to Mr. FRASER, St. Stephen's Chambers, Telegraph Street, LONDON, E.C.

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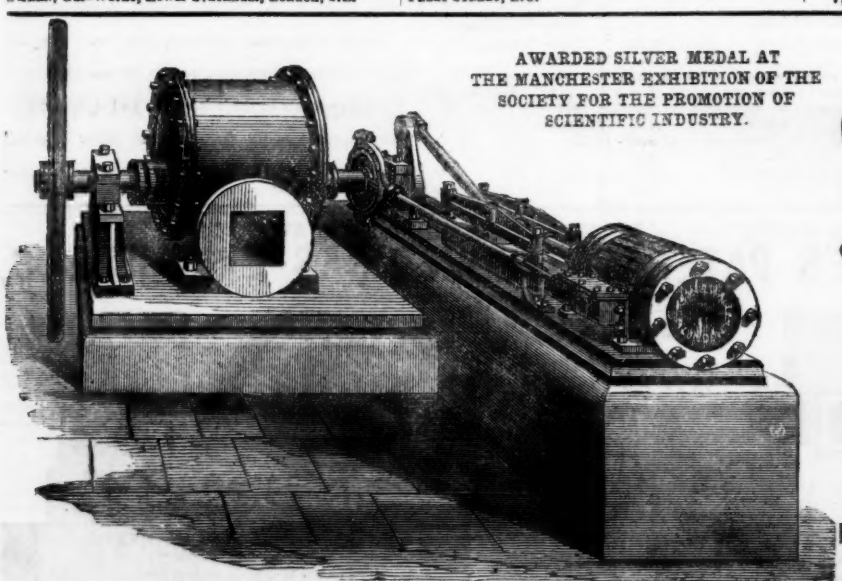

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"These Lamp-Governors are so superior that they are likely to supplant all others."—*Dr. Wm. Wallace, F.R.S.E., F.C.S.*

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Particulars on application to C. H. FIFIELD, Gas-Works, Desborough, near MARKET HARBOROUGH.

THE Swansea Gaslight Company have for immediate SALE, the following Plant:—

A 6-h.p. Patent Trunk Engine. (Beale.)
Cylindrical Egg-ended Boiler, 20 ft. by 4 ft. 6 in. (Beale.)
Exhauster to pass 15,000 feet per hour. (Beale.)
An 8-h.p. Grasshopper Engine. (Easton and Amos.)
Cylindrical Egg-ended Boiler, 20 ft. by 4 ft. 6 in. (Easton and Amos.)
Exhauster, 20,000 ft. per hour. (Beale.)
Tar, Liquor, and Water Pumps, Eccentrics, Shafting, and Driving Pulleys.
Wrought-iron Condenser, six vertical Legs, 30 ft. high, 24 in. by 6 in., with tar-boxes, dips, and syphons.
Wrought-iron Scrubber, 5 ft. diameter, 20 ft. high.
Cast-iron Scrubber, 5 ft. diameter, 20 ft. high.
A set of four cast-iron Purifiers, 12 ft. square by 5 ft. deep, with galvanized wrought-iron covers, lifting apparatus, four tiers of wooden sieves, 10-in. connexions and valves.

May be seen at the Gas-Works, Swansea. The whole in perfect working order; replaced by plant of larger dimensions.

Further particulars may be obtained on application to Mr. THORNTON ANDREWS, SWANSEA.

TO TAR DISTILLERS.

THE Victoria (Newmarket) Gaslight and Coke Company, Limited, are prepared to receive TENDERS for the surplus TAR made at their Works, for the year ending July 31, 1877.

Tenders to be sent to the undersigned before the 12th day of July inst., from whom any further particulars may be obtained.

THOMAS WILKINSON, Manager and Secretary.
Gas Office, Newmarket, July 1, 1876.

TENDERS are invited for the construction of a BRICK TANK for Gasholder. Diameter 36 ft. 6 in., depth 12 ft.

Further information may be obtained on application to the SECRETARY, Gas-Works, STONY STRATFORD, where plan and specification may be seen, or copies can be furnished at a small cost.

Tenders to be sent in by the 20th of July.

The Company do not bind themselves to accept the lowest or any tender.

SULPHATE OF AMMONIA.

WHY sell your Liquor when it pays you better to work it up yourselves?

Consult J. JUDGE, Chemical Plumber, Burner, &c., who has put up several sets for Gas Companies with success. Saturating Tanks, &c., made to order. Success sure, and nuisance got rid of.

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PATRONIZED BY THE ROYAL ARSENAL, WOOLWICH.

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Kite method of Repairing Church Spires and High Chimneys. Chimneys straightened, pointed, and hooped. Old Chimneys pulled down by a process requiring no scaffolding or stoppage of work, by competent workmen, under personal supervision. For Lightning Conductors—cheapness and method of fixing—apply to C. R. FERGUSON, 12, Canal Road, MILE END.

WIDNES WATER-WORKS.

THE Widnes Local Board invite Tenders for the sinking of a deep WELL and BORE HOLE upon land adjoining Netherley Bridge, Little Woolton.

Plans and specification may be seen at the Engineer's Office, Public Offices, Widnes.

Tenders, endorsed "Well," and addressed to the Chairman of the Gas and Water Committee, must be left at the above Offices not later than Ten a.m. upon the 31st of July.

The Board do not bind themselves to accept the lowest or any tende .

HENRY ROBERTS.
Public Offices, Widnes, July 4, 1876.

GAS TAR AND AMMONIACAL LIQUOR.

THE Directors of the Ashton-under-Lyne Gas Company are prepared to receive TENDERS for the surplus TAR and AMMONIACAL LIQUOR produced at their works, for Twelve months ending July 31, 1877.

Further particulars may be obtained on application to the undersigned, to whom tenders, endorsed "Tender for Tar and Water," must be sent on or before Saturday, July 15, 1876.

The Directors do not bind themselves to accept the highest or any tender.

DAVID CLARKE, Manager.
Gas Offices, June 29, 1876.

THE Gas-Works, at Soham, Cambridgeshire, comprising a most commodious well built and appointed Gas-House, Gasometer, Cottage, and suitable Buildings, situate on the Meerside, with the Yard, Main, Conduit, and other Pipes thereto belonging, and the Lamps and Lamp Posts in the streets of the Parish of Soham, will be offered FOR SALE BY AUCTION, by Mr. George Mainprice (by order of the Directors of the Soham Gas and Coke Company, Limited), at the Crown Inn, in Soham, on Friday, the 14th day of July, 1876, at Three for Four o'clock in the afternoon, punctually (subject to such conditions of Sale as will be then declared).

The works were erected in the year 1848, and during nearly the whole period since their construction have been let on lease at a rent of not less than £100 per annum, are in good repair and condition, and in full working order. They are conveniently situated with reference to the town, and offer a most eligible opportunity to an enterprising purchaser, as the consumption of gas has been steadily on the increase. The proposed line of railway from Ely to Newmarket (which is shortly to be commenced) is likely to be constructed parallel with the yard belonging to the Works, and the station will, according to the present plan of the Railway Company, be erected within a few yards of the same, thereby adding considerably to their present value.

The Gas-Works are freehold, and are now held by Mr. Robert Tebbitt, under a lease for seven years, which will expire on the 21st of August next, when possession may be had.

Further particulars, and conditions of sale, may be obtained of Messrs. HUSTWICK AND LIVETT, Solicitors, and of the AUCTIONEER, all of SOHAM.

TO COAL FACTORS AND OTHERS.

THE Directors of the Arundel Gas Company are willing to receive TENDERS, to be delivered at the Secretary's Office by Ten o'clock on Tuesday, the 18th day of July inst., for the delivery of a cargo of from 300 to 350 tons of Pelaw Main or Dean's Primrose GAS COALS, free of all cost, at the Piles, opposite the Gas-Works, at which a vessel can moor, not later than the 1st of September next.

Payment to be made within a month of delivery.

RICHARD HOLMES, Secretary.
Arundel, July 6, 1876.

SALFORD CORPORATION GAS-WORKS.

THE Corporation of Salford invite TENDERS for the supply of the CANNEL and COAL required at the various Gas Stations in Salford, for One, Two, or Three years, commencing on the 1st day of September next.

Forms of tender (upon which only tenders will be received) and all particulars may be obtained on application to the Engineer, Mr. Samuel Hunter, Gas-Works, Lamb Lane, Salford.

Tenders, endorsed "Cannel and Coal Contract," to be delivered to me on or before the 28th of July, 1876.

The Corporation do not bind themselves to accept the lowest or any tender.

By order,
CHRLS. MOORHOUSE, Town-Clerk.
Town-Hall, Salford, June 29, 1876.

TO GASHOLDER MAKERS.

THE Town Commissioners of Strabane are prepared to receive TENDERS, with plans and specifications, for the supply and erection of a Single-Lift Gasholder, 35 ft. diameter and 12 ft. high, with the necessary columns, guides, girders, pulleys, chains, counterbalance weights, pipes, valves, deep closets, pump, pipes, &c., complete.

For further particulars apply to the undersigned or to N. Tighe, Manager.

The Commissioners do not bind themselves to accept the lowest or any tender, nor will any allowance be made for plans or specifications.

Strabane is only twelve miles from Londonderry, with rail and canal communication.

Tenders received up to the 28th of July.

HUGH MAGUIRE, Clerk to the Commissioners.

ISLE OF WIGHT WATER-WORKS.

THE Isle of Wight Water-Works Company are prepared to receive TENDERS for the construction of a pair of FILTER-BEDS, Receiving and Pure Water RESERVOIRS, and other Works at their pumping-station at Sandown.

The drawings and specification may be seen, and a copy of the bill of quantities, with form of tender, may be obtained (on payment of two guineas, which will be returned when the tender shall have been made *bonâ fide*), by application to the Company's Engineer, Mr. G. W. Stevenson, 4, Westminster Chambers, Victoria Street, Westminster, on and after Wednesday, the 12th inst., and tenders must be sent in, under cover, addressed to me at my Offices, in Ventnor, on or before Friday, the 21st of July inst.

By order,
R. C. DERBY, Secretary.
Sandown, Isle of Wight, July 6, 1876.

TENDERS FOR GAS COALS.

THE Directors of the Slough Gas and Coke Company are prepared to receive TENDERS for a supply of 1000 tons (21 cwt. to the ton) of either of the undermentioned GAS COALS, viz.:—

New Pelton.
Holmside.
Ravensworth Pelaw, or
Best Screened Silkstone Brights.

Sea Coals to be sheeted, delivered at the Slough Railway Station in such quantities as may be ordered by the Manager of the Works. Of course, parties may tender for either one, two, or the whole of the descriptions named.

Tenders to be delivered to the undersigned, endorsed "Tender for Gas Coals," on or before 6 p.m. on the 20th day of July inst.

ARTHUR THOMAS, Secretary.
Slough, Bucks, July 4, 1876.

JOHN HALL AND CO., STOURBRIDGE,

Manufacturers of FIRE-BRICKS, LUMPS, TILES,

AND EVERY DESCRIPTION OF FIRE-CLAY GOODS.

N.B.—A Stock of 15 and 16 in. CIRCULAR RETORTS always on hand. Other kinds made to order on short Notice.

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ATLAS METER-WORKS, OLDHAM,

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STATION-METERS, GOVERNORS,
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And every Description of Gas Apparatus.

Will shortly be ready, price 18s., bound in cloth, lettered,

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(JANUARY TO JUNE, 1876.)

OF THE

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CLOTH CASES, GILT LETTERED,
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GUARANTEED TO HEAT UNIFORMLY WITH THE MINIMUM OF FUEL.

Coloured lithograph copies of Working Drawings of beds, of 1, 2, 3, 5, 6, and 7 Retorts each, so clearly arranged and fully shown, as to be easily understood by any retort-setter or bricklayer, having just been made of these valuable settings, they can now be supplied with detailed specifications, immediately on receipt of orders.

Applications to be made to Mr. THOS. NEWBIGGING, Gas and Consulting Engineer, 3, Norfolk Street, MANCHESTER.

SZERELMEY STONE LIQUID,

Which waterproofs and casehardens every kind of masonry, and

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"The only permanent preservative against rust," having enjoyed the approval and recommendation of the most eminent authorities, including SIR CHARLES BARRY, SIR R. I. MURCHISON, PROFESSOR FARADAY, "THE TIMES," "PALL MALL GAZETTE," "ENGINEER," "BUILDING NEWS," "IRON," and very many others.

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THE NEW MODE OF BUILDING.

TO BUILDERS OR GENTLEMEN WHO WISH TO CONSTRUCT HOUSES ON THE NEW MODE OF BUILDING, ON A SIMPLE LICENCE, IN DISTRICTS NOT AT PRESENT LICENSED.

BY Recent Reductions in the cost of producing the Apparatus, I am enabled to construct and LET ON HIRE, for periods of not less than three months certain, A SET OF GEAR, consisting of a Hand Block Press, and Moulds for Slabs, and Plain Block Moulds, for 4½-in., 6-in., 9-in., and 12-in. Walls (the Blocks to be either 6 in. or 9 in. in depth, according to order, but in all cases each Block is half a yard in length), on receiving a deposit of £65; the rate charged for hire being 10s. per week for the press, and 1s. 6d. per week for each of the moulds.

Moulds for fluted or grooved Blocks will be loaned at the same rate. On returning the apparatus to the Birkenhead Station, carriage paid, the royalty of 7s. 6d. per habitable room in each house built, and for miscellaneous uses of the Blocks at 2d., 3d., or 4d. per eight Blocks or Slabs, or superficial yard of wall respectively, will be deducted, and the balance of the £65 will be returned. Full working wear will be allowed, but breakages must be paid for. Small wood gear can be found by the licensee, and be made at any country joiner's shop. The Blocks can be made either in winter or summer, and the minimum thick shell Blocks, with Portland cement, if it costs 80s. per ton, or with sand, bearing a cost of carriage equal to that from London to Birkenhead, these Blocks, with hydraulic lime, mortar, and stones for "filling in," yield a profit in many places of 50 per cent. over brickwork, with all the appearance of the best dressed Ashlar Stones, and the walls can be made perfectly waterproof. The thin shell Blocks of "⅛ to 1 concrete," with red or grey sand, are the most convenient to make in a country place. If required, a man will be sent with each machine to put it up and work it at 7s. per day, *plus* train and lodging expenses, specially to instruct in one clear day any ordinary workman in the process of making the blocks. A guarantee is given on the average results of the different licensees to a limit of £100, that the buildings constructed on the new mode are superior and more stable than any system of building with bricks and mortar of the same thickness of walls; also that walls of half the usual thickness are, on this principle, sufficiently strong for many of the present building purposes. The order will be placed in course on receiving the deposit.

References: The first buildings, three-storeyed houses, built by John Tainsh, Esq., of Hamilton, N.B., the first licensee in Scotland; the buildings by other licensees now granted in England and Ireland, and will be given as soon as they are sufficiently advanced. Bank reference: The National Bank of Liverpool (Birkenhead Branch).

Sole licences are granted by special arrangement.

Send for illustrated circular, enclosing six postage stamps, or card as a Builder or Architect, to 2, Ferry Buildings, Birkenhead.

JOHN C. SELLARS, F.C.S.

EXTRACT FROM THE "BRITISH DAILY MAIL," *Monday, June 5*, 1876.

CONCRETE BUILDING IN HAMILTON.

"There has long been a demand for workmen's houses in the neighbourhood of Hamilton, and although a good many such buildings have been erected of late, the requirement still seems to be in advance of the supply. The great cost of building, both in respect to the high rate of labour, as well as the cost of material, has hitherto had a deterrent effect. With a view of meeting these difficulties, attention has been directed to the use of some material other than stone, brick, and mortar. Mr. J. C. Sellars, of Birkenhead, has recently patented a new invention for building with concrete, composed of sand and cement, and our enterprising townsman, Mr. John Tainsh, has secured the right of using this material in Hamilton. He is now in the course of erecting a large block of three-storeyed houses in the immediate vicinity of the Gas-Works. We purpose explaining the mode of operation to our readers. The material is prepared in hollow Blocks, of about 9 in. by 18 in. over all, and is composed of one-fourth sand to one part Portland cement. * * * The actual building operations now commence, and as the Blocks are accurately fitted and of uniform size, the work is carried on with considerable dispatch by comparatively unskilled labour." * * * *

* * * "The surface of the blocks being perfectly smooth, when the joints are pointed the walls require no plastering whatever, and are ready to receive either paper or paint. The advantages in this system of building are numerous, and consist among others of being considerably cheaper, more durable, better adapted to resist damp, and become harder by exposure to the atmosphere, taking up less room, being more sightly in appearance, and besides possessing sanitary advantages over ordinary masonry work. The style of building for lofty edifices looks somewhat slight to the Scotch eye, being, as we are, accustomed to heavy masonry; but looking at it from an English point of view it is fully as substantial as ordinary buildings."

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Manufactory for every description of Casting and Machinery for Gas-Works and Water-Works.

Warehouse in London for Cast-Iron Pipes and Connexions of all sizes and in any quantity, Scott's Wharf, Bankside, Southwark.

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CAST-IRON SOCKET-PIPES,
From 3 in. to 8 in. diameter.
Apply, by letter, to
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MANUFACTURER OF EVERY DESCRIPTION OF
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A LARGE QUANTITY OF RETORTS ALWAYS IN STOCK.

Circular .	14 in.,	15 in.,	16 in.,	18 in.
Ovals . .	17 in. × 14 in.,	17 in. × 15 in.,	20 in. × 15 in.,	21 in. × 15 in., &c.
D's. . .	14 in. × 14 in.,	15 in. × 12 in.,	15 in. × 13 in.,	17 in. × 14 in., 18 in. × 13 in.
	18 in. × 15 in.,	20 in. × 16 in.,	22 in. × 14 in.,	24 in. × 14 in., 24 in. × 15 in., &c.

Special attention given to the execution of Export Orders.

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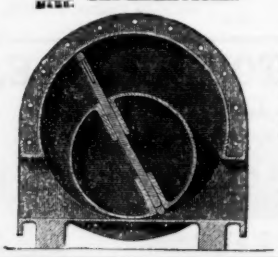
J. BEALE'S PATENT GAS EXHAUSTER.



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MR. J. BEALE, of East Greenwich, having retired from business, has made an arrangement with B. DONKIN & CO. for the sole manufacture of his Patent Solid-Slide Gas Exhausters.

B. D. & Co. also make Steam-Engines to drive Gas Exhausters direct or otherwise, and Gas-Valves.

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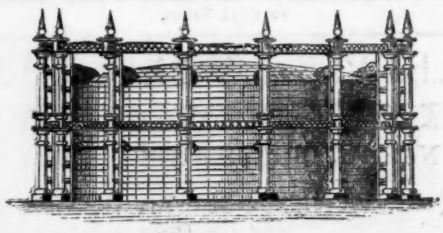

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GAS APPARATUS OF EVERY DESCRIPTION,
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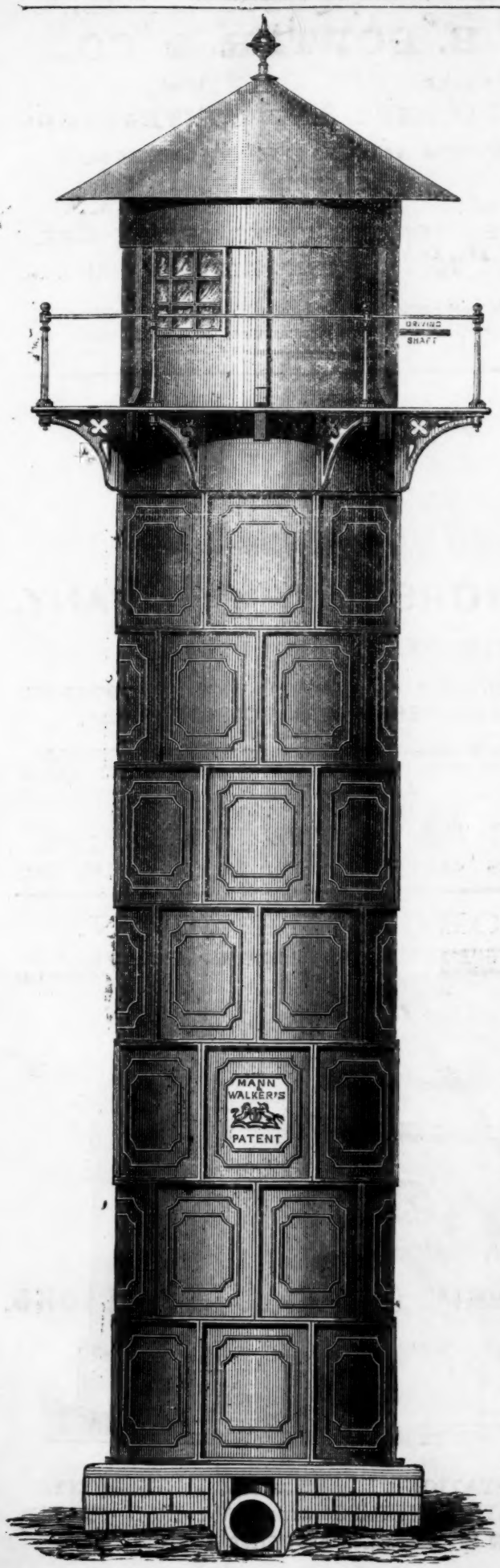
N.B—Estimates for all Gas Plant and Remodelling supplied on application.



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By Letters Patent in Great Britain, Europe, and the United States of America.

By some important improvements recently patented, the purifying power of these Scrubbers has been much increased, and a stronger ammoniacal solution obtained, which is found to absorb a large portion of the carbonic acid contained in gas, effecting an important saving in money and labour in the lime purifiers, and where oxide only is used, the increase in the illuminating power of the gas obtained by these Scrubbers is shown in a remarkable degree, in consequence of the large quantity of carbonic acid removed from the gas.

It is to be particularly noted that the im-portant results of these Scrubbers do not depend upon the machinery alone. The entire internal construction of the Scrubber bears an almost equally important part. For this reason, where it is desirable to convert existing Scrubbers, whose dimensions happen to be suitable, the work commences by ripping out the whole of the interior of the shell, and beginning the internal construction *de novo* from bottom to top.

They are, in all cases, constructed under guarantees to perfectly perform their work. They are now extensively used in the largest gas-works of London and the chief cities of Europe, the number in use exceeds **one hundred,** and their perfect efficiency and profit to a gas company have been fully established with every variety of coal used in Europe. References can be given to the largest gas-works in Europe.

By their use the department of purification from ammonia upon a gas-works is made complete, without the aid of prepared oxide of iron, chemicals in purifiers, or any other supplementary process, and the whole ammoniacal residual product contained in the coal is absorbed and obtained in the form most profitable to a gas company, while the requirements of all Acts of Parliament and of the Board of Trade, relating to incorporate gas companies, are satisfied.

Foul Gas, properly condensed, entering the inlet is, by once only passing through the Scrubber, completely purified from ammonia with regular certainty day by day, without any further trouble, or any other process, effected by a very small quantity of clear water let into the machinery room at the top of the Scrubber, which is discharged at the liquor outlet at the bottom, from Newcastle coal at about 18 to 20 ounces strength, from Yorkshire and other coals, generally from 25 to 30 ounces strength; while acidulated litmus or turmeric exposed at the Scrubber outlet will not show the slightest discoloration, and there is not a quarter of a grain of ammonia per 100 feet left unabsorbed.

They contain their own engine power, re-quiring only a small inappreciable quantity of steam from the gas-works boiler, and are then complete in themselves, ready for service.

Applications relating to dimensions and prices should be addressed to us, C. and W. Walker, 8, Finsbury Circus, London, E.C., or to Mr. William Mann, late Superintendent of the Chartered Gas-Works, Blackfriars, London; they should state approximately the largest make of gas in 24 hours on a winter's day, and the smallest make on a summer's day, to be purified.

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PATENT FUEL AND LIME FOR PURIFYING FROM FOUL LIME.

By a simple process the Foul Lime is converted into Fuel, by the combustion of which the lime is reproduced as a purifying agent.

Licences to work the invention will be granted to Gas Companies on very reasonable terms.

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The adoption of the above invention, without a licence from the Patentee, will be an infringement of the patent, and will subject the person or company guilty of such infringement to legal process.

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Is prepared to open the Books, and, if necessary, keep the Accounts of Gas and Water Companies.
To examine the Books and Accounts, and prepare Balance-Sheets for the information of Directors.
To assist Secretaries in preparing Balance-Sheets, according to the "Gas-Works Clauses Act, 1871;" or may be consulted with respect to Accounts generally.

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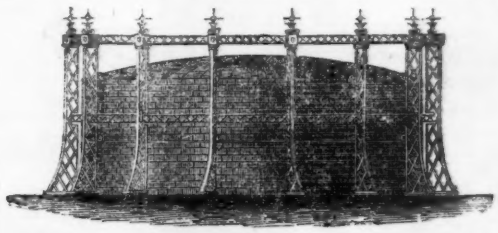
ESTIMATES FOR GAS-WORKS OF ANY SIZE.
REFERENCES TO 500 WORKS ALREADY ERECTED.

N.B.—It is most particularly requested that all Communications be addressed to the FIRM ONLY, as circumstances have arisen which render this necessary.



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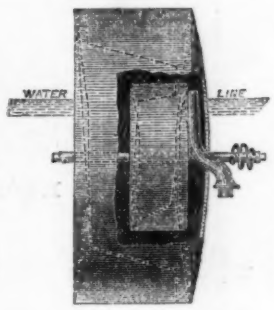
From "THE JOURNAL OF GAS LIGHTING," Jan. 5, 1875.

"The changes effected in the construction of the wet meter are such that it now occupies a position which it never held before—that of an unvarying measure. . . . Both company and consumer are now equally protected, perfect accuracy of measurement is obtained, and that, too, without the least increase of mechanism, or the action of the meter in the least degree being prejudicially affected."



BRITISH ASSOCIATION of GAS MANAGERS, Leeds, 1875.

Inaugural Address of the President, JAMES PATERSON, Esq., F.G.S., of Warrington.

"There are, however, degrees of what may properly be termed excellence; and this leads me to notice one of the most beautiful applications which science has yet devised in the construction of the meter, and which has rendered it an absolutely reliable and unvarying instrument. . . . The object aimed at, and most admirably accomplished, is to change the varying measurement of a varying water-line to an unvarying measure with a varying water-line and annulus."

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"SELF-REGULATING DRUM" GAS-METER.

It is the ONLY Meter in which reliance can be placed.

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It is the ONLY Meter that POSSESSES AN UNVARYING MEASURING-CHAMBER.

It is the ONLY Meter FREE FROM delicate and complex compensating arrangements for maintaining water-line.

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Owner of the Works at which Fire-Clay Retorts were first made), can supply

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References can be given to managers of above a hundred Gas-Works whom he supplies.

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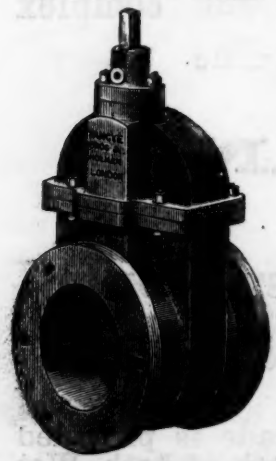

Inch.	s.	d.
3	33	0
5	40	0
6	66	0
7	81	0
8	96	0
10	100	0
14	140	0

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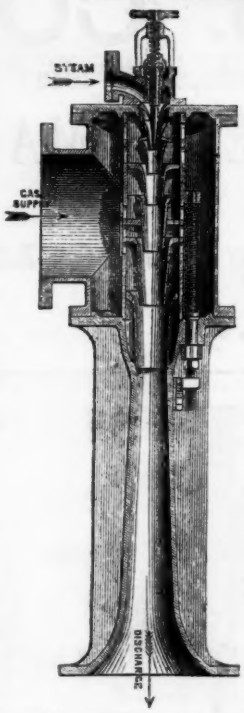

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Small Cost—Compactness—Perfectly Self-Acting—Self-Regulating—Self-Cleansing—No Steam-Engine—No Attention—No Extra Room Required—No Wear and Tear—No Noise—No Oscillation in Vacuum, or Back Pressure.

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E. KÖRTING'S PATENT STEAM-JET REVIVIFYING BLOWERS FOR THE PURIFYING MATERIAL.

W. CLELAND'S PATENT STEAM SCRUBBER,

Combining small cost and thorough efficiency, with absence of any mechanical means and necessity of renewing the scrubbing material.

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SOLE AGENT FOR ENGLAND AND WALES.

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AND MANUFACTURERS OF

PUMPING MACHINERY of every Description.

SOLE LICENSEES AND MANUFACTURERS FOR GREAT BRITAIN OF

BLAKE'S PATENT STEAM-PUMPS,

More than 8000 in use,

ESPECIALLY ADAPTED FOR USE IN GAS AND CHEMICAL WORKS, FOR PUMPING TAR, WATER, AMMONIACAL LIQUOR, ACIDS, &c.

The following are some of the prominent advantages of the BLAKE PUMP:—

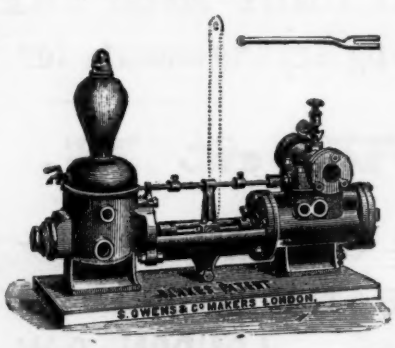
It will start at any point of stroke.

It has no dead point.

It works fast or slow, with the same certainty of action.

It is economical. Has a lead on the slide-valve.

It is compact and durable.



It is interchangeable in all its working parts.

It will deliver more water than any other pump.

It is made of best materials in the most workmanlike manner.

Can be worked at 20 strokes per hour, or 200 strokes per minute.

This Illustration represents Boiler-Feed Pumps, Sizes Nos. 1, 2, and 3, with Hand Lever for working Pump when Steam is not available.

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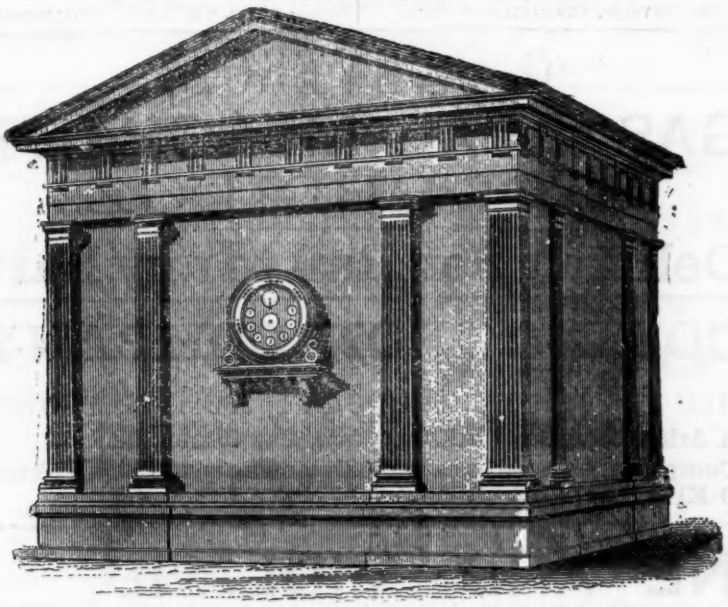

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GAS COOKING APPARATUS.

Home and Foreign Orders promptly attended to.

All Sizes of CONSUMERS METERS, STATION-METERS, and GOVERNORS generally in Stock.

Orders almost invariably despatched on the day of receipt.

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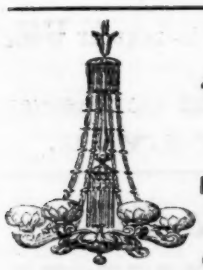

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WALL LIGHTS, AND LUSTRES FOR GAS AND CANDLES.

TABLE GLASS OF ALL KINDS.

CHANDELIERS IN BRONZE AND ORMOLU. MODERATOR LAMPS.

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RETORT SETTINGS—giving great Economy of Fuel.

STEAM-ENGINES and EXHAUSTERS, FOUR-WAY VALVES.

FUEL-MACHINE, for Compressing Breeze and Tar.

WASHERS, SCRUBBERS, and PURIFIERS, that Economize Space and Cost.

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Manufacturers of GAS-RETORTS, GLASS-HOUSE FURNACE & BLAST-FURNACE BRICKS LUMPS, TILES, and every description of FIRE-BRICK.

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PREVENTS WASTE OF GAS FROM RETORTS;

SAVES CLAY RETORTS FROM DESTRUCTION BY FIRE;

GREATLY ECONOMIZES THE USE OF FIRE-BRICKS;

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THE ORIGINAL MANUFACTURER OF

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Beg leave to call the attention of Gas Companies to the superior quality of their

CANNEL FOR GAS-MAKING PURPOSES.

This Cannel produces in actual working, in iron retorts, 9200 cubic feet of 32-candle gas, and upwards of 11 cwt. of coke, and in clay retorts will produce 11,500 cubic feet of 25·9-candle gas.

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Waggons supplied for delivery by railway to any part of England or Wales.

For particulars, prices, and rates of freight, apply to The Coppa Colliery, Mold, FLINTSHIRE.

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POPE & PEARSON, LIMITED, have now the authority of several of the most eminent Gas Engineers of London in stating that their Coal yields *in practical working over 10,000 cubic feet of gas, with an illuminating power of 16 candles;* or by the standard burners now used by the London Gas Companies, an illuminating power equal to 17½ candles.

One ton yields 12½ cwt. of good coke. This Coal can be shipped from Hull, Goole, Liverpool, Morecambe, and Barrow.

For further particulars, apply to POPE AND PEARSON, LIMITED, West Riding and Silkstone Collieries, near LEEDS.

HEBBURN MAIN GAS COALS.

Cubic feet of Gas yielded per ton . . .	10,050
Illuminating power in sperm candles . .	15·4
Yield of coke per ton of good quality . .	13½ cwts.

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The Subscriber is prepared to contract for the supply of all the principal SCOTCH CANNEL COALS. Prices and Analyses of the various Coals will be forwarded on application.

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This Coal yields 11,000 cubic feet of gas and 13½ cwts. of coke per ton.

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Supply the Best Wigan Arley Mine Gas Coal, Gas Nuts, Gas Cannel, &c.

N.B.—The Wigan Coal and Iron Company, Limited, are exclusive owners of the well-known HAIGH HALL AND KIRKLESS HALL GAS COAL COLLIERIES.

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GAS COAL & CANNEL.

EMOR G. WRIGLEY

Has on hand a quantity ready for immediate delivery, and is prepared to contract for Supplies during the years 1876 and 1877.

Can strongly recommend his real OLD SILKSTONE GAS COAL, which will give, in regular work, 10,200 feet 16·6-candle gas, and 12 cwt. superior coke.

PRICES AND ANALYSIS WILL BE FORWARDED TO ANY PART ON APPLICATION TO THE CHIEF OFFICE,

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MESSRS. NEWTON, CHAMBERS, & CO.,

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NEAR SHEFFIELD,

STRONGLY RECOMMEND A TRIAL OF THEIR

CELEBRATED SILKSTONE GAS NUTS.

Analysis by F. J. EVANS, Esq., Chartered Gas Company, Horseferry Road, Westminster:—

(COPY.)

	Cubic Feet of Gas per Ton of Coal.	Illuminating Power in Candles.	Coke per Ton of Coal used.	Ash in Coke, per Cent.	Sulphur in Coal, per Cent.
Silkstone Nuts . . .	10·800	15·85	12·66 cwt.....	6·0	0·69

NOTE.—The illuminating power of the gas was tested by the standard burner now used in London by the Gas Referees, under the City of London Gas Act, 1868.

Horseferry Road, Westminster, March, 1870. (Signed) F. J. EVANS.

These Nuts are extensively used by various Gas Companies throughout the Kingdom, who bear strong testimony to their value.

APPLICATIONS FOR PRICES, &c., TO BE SENT DIRECT TO THE COLLIERY, AS ABOVE.

THE SILKSTONE & DODWORTH COAL & IRON COMPANY, LIMITED,

DODWORTH, BARNSLEY.

BENJAMIN WHITWORTH, Esq., M.P. . . . . Chairman.
Mr. RICHARD HARTLEY . . . . . Managing Director.

REAL OLD SILKSTONE GAS COAL.

JAMES PATERSON, Esq., Gas Engineer, of the Warrington Gas Company, reported, Aug. 10, 1875:—

"This Coal possesses remarkable qualities as a gas and coking coal, and appears SECOND TO NONE IN THE KINGDOM. It contains the large quantity of 699 lbs. of illuminating matter, and 1498 lbs. of coke to the ton, and produces **12,240** cubic feet of 16·66 candle gas."

The above Company are raising nearly a thousand tons of the Real Old Silkstone Gas Coal per working day.

PRICES QUOTED TO ANY RAILWAY STATION, OR F.O.B. HULL, GRIMSBY, GOOLE, KEADBY, LIVERPOOL, AND FLEETWOOD.

ALBERT GAS COAL.

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SILKSTONE COAL COMPANY,
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CAN OFFER A

GAS COAL

Of superior quality, delivered at any station in England and Wales.

Purified gas per ton of coal in cubic feet (average)	10,775
Weight of coke in lbs. per ton of coal	1,465

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THE LOCHORE AND CAPLEDRAE CANNEL COAL COMPANY, LIMITED.

Works: LOCHORE by LOCHGELLY, FIFESHIRE. Office: CUSTOM HOUSE CHAMBERS, LEITH.

This Company request attention to the very superior quality of their Cannel Coals.

1. The following are the practical results given by Dr. Wallace, of Glasgow, of analyses of their Lochore and Capledrae Cannels:—

	Sample worked at Capledrae.	Sample worked at Lochore.
Gas per ton of coal, at 60° Fahr. and 30 inches barometric pressure . .	13,095 cubic feet.	11,760 cubic feet.
Illuminating power, in standard sperm candles, by union jet consuming 5 cubic feet per hour, at ·5-inch pressure	32·91	34·83
Value of 1 cubic foot of gas in grains of sperm	780	836
Equivalent of a ton of coal in pounds of sperm candles	1,459	1,404
Durability of 1 cubic foot by 5-inch flame	69 minutes.	71 minutes.
Gravity of the gas (air = 1000)	596	594

Remarks.—This (the sample from Capledrae) is a Cannel Coal of first-class quality, giving 13,000 feet of 33-candle gas. It contains only a minute proportion of sulphur, and the ash is almost quite white. The coke is of rather inferior quality.

Remarks on Sample from Lochore.—This is a Cannel Coal of first-class quality, giving a large yield of very rich gas and a coke of medium quality.

2. The following are the practical results of analyses by Dr. Wallace of the Company's Waverley Cannels:—

	Capledrae Waverley.	Lochore Waverley.
Gas per ton of coal, at 60° Fahr. and 30 inches barometer	9,120 cubic feet.	11,145 cubic feet.
Illuminating power, in standard candles, by union jet consuming 5 cubic feet per hour, at ·5-inch pressure	36·62	33·09
Value of 1 cubic foot of gas in grains of sperm	878	794
Equivalent of a ton of coal in pounds of sperm candles	1,145	1,264
Durability of 1 cubic foot of gas by 5-inch flame	80 minutes.	67 minutes.
Gravity of the gas (air = 1000)	677	597

Remarks on the Sample of Capledrae Waverley.—This Coal gives fully 9000 feet of gas of 36½ candles, and is admirably adapted for bringing up the quality of gas made from common coal or inferior qualities of cannel. The tests were made at a rather high temperature, this being one of the coals that stand a very high heat without serious diminution of the illuminating power of the gas The coke contains 60 per cent. of ash, and is therefore almost valueless, but the proportion of sulphur is very moderate.

Remarks on the Lochore Waverley.—This is a first-class Cannel Coal, giving 11,000 cubic feet of 33-candle gas. The quantity of sulphur is very minute, and the ash is nearly white. The coke is of inferior quality, but not wholly valueless.

Applications for full Copies of Analyses and Prices may be made to the Company.

OFFICE: CUSTOM HOUSE CHAMBERS, LEITH.

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DRY GAS-METERS,

PRIZE MEDALS.
LONDON, 1851;
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COMBINING ALL THE LATEST IMPROVEMENTS,

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Of the highest excellence.

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Of the most perfect description for all purposes relating to Gas.

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THE UNVARYING WATER-LINE GAS-METERS,

IMPROVED DRY GAS-METERS, in Cast-Iron or Tin-Plate Cases;

STATION-METERS, ALL SIZES, up to 15 feet Square, with PLANED JOINTS;

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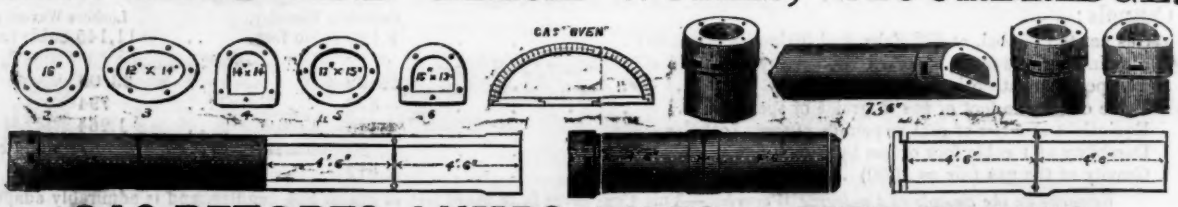

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